5. DETAILED REQUIREMENTS

5.1 <u>Standards for reference point A</u>. This section defines the standards applicable at the interface between the subscriber terminal equipment (or the subscriber's network equipment) and the local-network element (reference point A).

5.1.1 <u>ISDN-terminal to base information transfer system</u>. The terminal equipment interfacing with the base information transfer system shall comply with the existing ANSI standards and CCITT recommendations cited in 5.1.1.1 to 5.1.1.3.3, and shall conform to FIPS 146 for ISDN basic rate access at the user-to-network interface. This interface is applicable to both circuit-switched and packet-switched service.

5.1.1.1 <u>Layer 1 (the physical layer)</u>. Layer 1 provides the mechanical, electrical, functional, and procedural characteristics to activate, maintain, and deactivate a physical circuit. Layer 1 allows for the transparent transmission of bits between the terminal equipment and local-network elements. The interface between the terminal equipment and local-network elements shall comply with ANSI T1.601. This interface shall support up to two full-duplex, 64-kbps information bearer channels; one full-duplex, 16-kbps signaling channel; and one full-duplex, 16-kbps overhead channel over a single twisted pair of telephone wires.

5.1.1.1.1 <u>Physical characteristics</u>. The wiring polarity and connector shall comply with ANSI T1.601, the section titled *Physical Characteristics*.

5.1.1.1.2 <u>Transmission method</u>. The line code used on the twisted pair of telephone wires shall be 2B1Q (2 binary, 1 quaternary) as defined in ANSI T1.601, the section titled *Transmission Method*.

5.1.1.1.3 <u>Functional characteristics</u>. The modulation rate of the 2B1Q signal shall be 80 kilobaud. The timing signal for the subscriber's terminal equipment shall be slaved to the signal received from the local-network element. The two 64-kbps bearer channels, the 16-kbps signaling channel, and the 16-kbps overhead channel shall be multiplexed in accordance with the frame structure defined in ANSI T1.601, the section titled *Functional Characteristics*.

5.1.1.1.4 <u>Electrical characteristics</u>. The subscriber's terminal equipment shall comply with the impedance and return loss, longitudinal output voltage, longitudinal balance, jitter, and dc characteristics defined in ANSI T1.601, the section titled *Electrical Characteristics*.

5.1.1.2 <u>Layer 2 (the data link layer)</u>. Layer 2 defines the procedures required to establish, maintain, and disconnect the data link between the subscriber's terminal equipment and the network.

5.1.1.2.1 <u>Signaling channel (the D-channel)</u>. The link access procedure on the D-channel shall comply with ANSI T1.602. T1.602 contains the complete text of CCITT Recommendations Q.920 and Q.921, which specify the frame structure, the procedure elements, the field formats, and the link access procedures (LAP) for the D-channel (LAPD). Out-of-band signaling procedures (D-channel) shall be used to negotiate a packet-switched or circuit-switched connection for each information bearer channel.

5.1.1.2.2 <u>Signaling in the bearer channel</u>. Packet-switched calls shall be connected to the local packet handler. Remaining signaling information, including the called user address, shall be provided in the bearer channel and shall comply with the link access procedures balanced (LAPB), as defined in sections 2.2, 2.3, and 2.4 of CCITT Recommendation X.25 for basic (modulo 8) operation. Connections for circuit-switched calls shall be completed based on D-channel signaling only. At the user-to-network interface, layer 2 does not apply to information bearer channels, for circuit-switched calls.

5.1.1.3 <u>Layer 3 (the network layer)</u>. Layer 3 protocols provide the information required to route calls through the local- and wide-network elements to the destination-terminal equipment. Three types of signaling messages shall be used to control circuit-switched and packet-switched connections: call establishment, call clearing, and miscellaneous messages. A list of the messages in each category is provided in tables I and II.

5.1.1.3.1 <u>Circuit-switched connections</u>. The definition, message format, and information element coding for messages used to control circuit-switched connections shall be as defined in ANSI T1.607 and 5.1.1.3.2. ANSI T1.607 is aligned with CCITT Recommendation Q.931. It specifies the messages and procedures used for control of circuit-switched connections at user-to-network interfaces. The messages are exchanged over the D-

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channel and are applicable to both basic-rate and primary-rate interfaces.

TABLE I. Messages for circuit-switched connection control.

CALL ESTABLISHMENT	CALL CLEARING	MISCELLANEOUS
Alerting	Disconnect	Information
Call Proceeding	Release	Notify
Connect	Release Complete	Status
Connect Acknowledge	Restart	Status Inquiry
Progress	Restart Acknowledge	
Set-up		
Set-up Acknowledge		

TABLE II. Messages for packet-switched connection control.

CALL ESTABLISHMENT	CALL CLEARING	MISCELLANEOUS
Alerting	Disconnect	Status
Call Proceeding	Release	Status Inquiry
Connect	Release Complete	
Connect Acknowledge	Restart	
Progress	Restart Acknowledge	
Set-up		

5.1.1.3.2 DSN features. The circuit-switched call control
procedures described in ANSI T1.607 shall be used in the control
of supplementary procedures as specified in ANSI T1.610, except
where modified to provide for DSN features. The following DSN
features shall be implemented in accordance with mandatory
Appendix D:

   a.   Multi-level precedence and preemption (MLPP)

   b.   Off-hook (or hot-line) service

   c.   Preset conference calling

    d.   Community-of-interest service

5.1.1.3.3 <u>Packet-switched connections</u>. The definition, message format, and information element coding for messages used to control packet-switched connections are defined in ANSI T1.608. ANSI T1.608 specifies the messages and procedures used for control of packet-switched connections at user-to-network interfaces. The procedures in T1.608 shall be used for the following two cases:

    Case A: <u>Circuit-switched access to packet-switched public data network</u>. Layer 3 signaling between the subscriber's terminal equipment and the public data network (PDN) shall comply with the packet layer protocol defined in section 3 of CCITT Recommendation X.25. Only the B-channel is used after the circuit-switched connection to the PDN is completed. Signaling for the circuit-switched portion of the call shall be accomplished using the D-channel.

    Case B: <u>Packet-switched access to an ISDN virtual circuit service (B- and D-channels)</u>. Layer 3 signaling between the subscriber and the ISDN packet handler shall comply with the packet layer protocol defined in section 3 of CCITT Recommendation X.25. The connection between the subscriber's terminal equipment and the packet handler may be a full period connection or may be obtained using D-channel signaling as defined in ANSI T1.608. In this case, the information bearer channel may be either a B- or D-channel.

    A list of the ANSI T1.608 messages applicable to D-channel signaling is provided in table I for Case A and table II for Case B.

5.1.2 <u>Terminal-equipment to tactical-network interface</u>. The terminal equipment interface for tactical subscribers shall comply with the existing MIL-STD-188 series standards and CCITT Recommendations cited in 5.1.2.1 and 5.1.2.2.

5.1.2.1 <u>Tactical circuit-switched connections</u>. The terminal equipment interface for tactical circuit-switched subscribers shall comply with 5.1.2.1.1 to 5.1.2.1.3.

5.1.2.1.1 <u>Layer 1 (the physical layer)</u>. Loops between tactical
terminal equipment and tactical local-network elements shall
operate on a full-duplex, 4-wire basis with a transmit pair and a
receive pair. Common battery may be provided between the pairs
by a local-network element. The loop shall operate at a 16-kbps
information rate in each direction, using conditioned diphase, as
defined in MIL-STD-188-200. The signal amplitude shall be 3
volts, plus or minus 10 percent, with a source impedance of 125
ohms, resistive.

5.1.2.1.2 <u>Layer 2 (the data link layer)</u>. Tactical loop
signaling shall be in-band, using 8-bit cyclically permutable
codewords. The codewords shall be repeated continuously until
acknowledged or timed-out in accordance with TT-A3-9012-0046, the
sections titled *Signaling codewords and Signaling timeout*. The
idle state, for the signaling channel, shall consist of
alternating ones and zeros.

5.1.2.1.3 <u>Layer 3 (the network layer)</u>. Tactical loop signaling
shall be in accordance with TT-A3-9012-0046, the section titled
Signaling and cryptophases. Certain codewords shall be used to
represent more than one signaling statement. The ambiguity shall
be resolved by considering the context of the signaling sequence
involving use of the codewords.

5.1.2.2 <u>Tactical packet-switched connections</u>. As illustrated in
figure 4.2, a host computer or ES may be connected to a tactical
packet switch in three ways:

   a.   By direct cable connection to a packet switch.

   b.   By connection to a LAN through an IS to a packet switch
        (the IS may be located with the LAN or with the packet
        switch).

   c.   By connection to a telephone through a circuit switch
        to a packet switch (in this case, the subscriber must
        first call up the local-packet switch).

5.1.2.2.1 <u>Layer 1</u>. The interface, at reference point A, shall
comply with MIL-STD-188-114 for 5.1.2.2 a and b. It shall comply
with 5.1.2.1.1 for 5.1.2.2c.

5.1.2.2.2 <u>Layer 2</u>. The protocol used to access the packet
switch shall comply with LAPB basic (modulo 8) operation, as

defined in sections 2.2, 2.3, and 2.4 of CCITT Recommendation X.25.

5.1.2.2.3 <u>Layer 3</u>. Network signaling to the packet switch shall comply with the packet layer protocols as defined in section 3 of CCITT Recommendation X.25.

5.1.3 <u>Net-radio-terminal to tactical-network interface</u>. Tactical network elements shall provide circuit-switched and packet-switched service to and from radio networks. Interoperability between the radio network and local-network elements shall be achieved by providing a net radio interface (NRI) for circuit-switched voice and data calls, or an IS function for packet-switched data communications.

5.1.3.1 <u>Circuit-switched connections</u>. Tactical circuit-switched network interfaces to net radio terminals shall use the same loop signaling protocols as described in 5.1.2.1, with the addition of a means to control the NRI gateway's push-to-talk function. These means may be manual (whereby a local operator monitors both sides of the interface), or automatic. Automatic operation may be achieved by voice-operated transmit (VOX), digitized push-to-talk control tone bursts (1231 Hz, transmit on; 1455 Hz, transmit off), dual-tone multifrequency (DTMF) digits (1 transmit on, 3 transmit off), or digital start-of-transmission/end-of-transmission codewords.

5.1.3.2 <u>Packet-switched data</u>. Tactical packet-switched network interfaces to and from net radio terminals shall use the same protocols described in 5.1.2.2. The IS function may be an integral part of the radio terminal located at the network gateway.

5.2 <u>Standards for reference point B</u>. This section defines the standards applicable at the interface between local-network elements and wide-network elements.

5.2.1 <u>ISDN base-level interface to reference point B</u>. Base information transfer systems shall comply with 5.2.1.1 to 5.2.1.3 at reference point B.

5.2.1.1 <u>Layer 1</u>. The signal at the wide-network interface shall comply with the following parameters as specified in ANSI T1.408:

a. Line code   Bipolar with 8-zero
                                 substitution (B8ZS) and 50%
                                 duty cycle.

b. B8ZS   Eight consecutive zeros shall
                                 be replaced with 000+-0-+ if
                                 the preceding pulse was
                                 positive and with 000-+0+- if
                                 the preceding pulse was
                                 negative.

c. Bit rate   1.544 Mbps.

|		
d.	Number of channels	24 (Normally 23 channels are used as information-bearer channels and 1 channel is reserved for common-channel signaling.)
e.	Frame format	193-bit frame (see figure 5.1).
f.	Frame repetition rate	8000 frames per second.
g.	F-bit signal bit rate and allocation	2000 bps of the 8000-bps F-bit signal shall be used for the frame alignment signal (FAS). To convey fault status and maintenance information, 4000 bps shall be available for use as a data link (data orderwire). Using the CRC-6 cyclic redundancy check as defined in ANSI T1.408, 2000 bps shall be available for performance monitoring.
h.	F-bit signal format	See table III.
i.	High rate signals	H_0=384 kbps; H_{10}=1472 kbps; H_{11}=1536 kbps. (H_{10} and H_{11} are optional services.)
j.	Time-slot assignment	Time slot 24 shall be used to transfer common-channel signaling information (D-channel), when it is present. A channel shall occupy an integer number of time slots and the same time-slot positions in every frame. A B-channel may be assigned any time slot in the frame; an H_0-channel shall be assigned any six slots in the frame, in numerical order (not necessarily consecutive); and an H_{10} channel shall be assigned time slots 1 to 23.

The assignment may vary on a call-by-call basis.
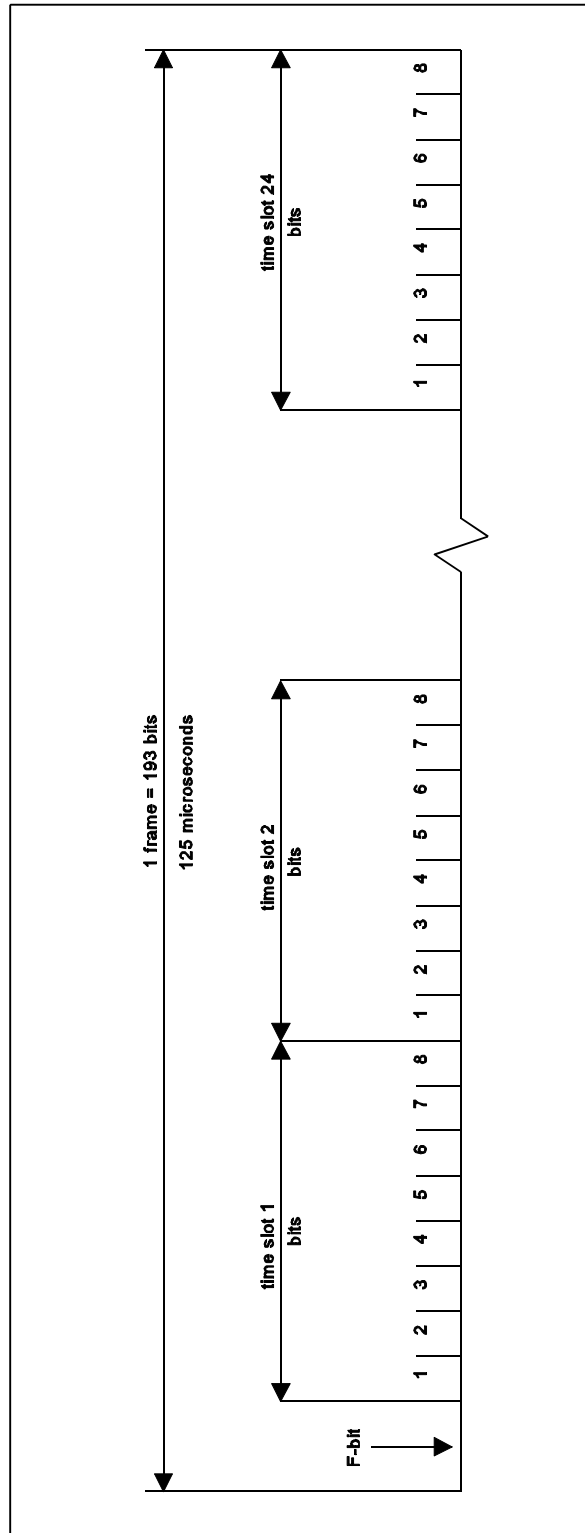
FIGURE 5.1. Frame format for a 1.544-Mbps signal.

TABLE III. <u>F-bit signal format</u>.

FRAME NUMBER	F-BITS			
	BIT NUMBER	**FAS**	**DL**	**CRC**
1	1		m	
2	194			C1
3	387		m	
4	580	0		
5	773		m	
6	966			C2
7	1159		m	
8	1352	0		
9	1545		m	
10	1738			C3
11	1931		m	
12	2124	1		
13	2317		m	
14	2510			C4
15	2703		m	
16	2896	0		
17	3089		m	
18	3282			C5
19	3475		m	
20	3668	1		
21	3861		m	
22	4054			C6
23	4247		m	
24	4440	1		

FAS = framing alignment signal
DL = 4-kbps data link
CRC = CRC-6 cyclic redundancy check
m   = data bit in maintenance channel

k.   Signaling data link   The signaling data link bit
                                   rate shall be 56 kbps,
                                   evolving to 64 kbps. Fifty-
                                   six kbps signals shall occupy
                                   bit positions 1, 2, 3, . . .,
                                   7 of the 64-kbps D-channel.
                                   The unused bit position shall
                                   be set to "1." The signaling
                                   data link shall be a
                                   bidirectional transmission
                                   path for common-channel
                                   signaling, comprising two
                                   "data channels" operating
                                   together in opposite
                                   directions at the same data
                                   rate. The signaling data link
                                   constitutes the lowest
                                   functional level (layer 1) in
                                   the SS7 functional hierarchy.
                                   SS7 shall be capable of
                                   operating over both
                                   terrestrial and satellite
                                   transmission links. The
                                   operational signaling data
                                   link shall be exclusively
                                   dedicated to the use of a SS7
                                   signaling link between two
                                   signaling points in SS7.

5.2.1.2 Layer 2. The data link layer shall provide for reliable
transfer of common-channel signaling information across the
physical channel. This shall include error control, message
sequencing, and message delimitation. Data link signaling
functions and procedures shall comply with ANSI T1.111, the
section titled *Signaling data link*. The data link layer shall
also be responsible for initializing the link and logically
disconnecting secondary stations.

5.2.1.3 Layer 3. The network layer shall comply with the
following requirements:

    a.   Layer 3 protocols shall comply with ANSI standards
T1.111 (sections 4 and 5), T1.112, T1.113, and T1.114.

b. The interworking relationship between the D-channel signal at the user-to-network interface and the ISDN-User Part, as defined in ANSI T1.113, shall comply with ANSI T1.609.

5.2.2 <u>Tactical network interface to reference point B</u>. Tactical local network elements are likely to change in the long-range future to reflect commercial 64-kbps ISDN architectures for fixed applications and 4.8-kbps architectures for mobile applications. Future tactical interfaces are likely to reflect these commercial standards when they are in place. The near-term standards for tactical local-network elements shall comply with 5.2.2.1 to 5.2.2.3 at reference point B.

5.2.2.1 <u>Layer 1</u>. Tactical common-channel signaling shall take place over an 8-kbps, full-duplex subchannel of the 16-kbps overhead channel. It shall be multiplexed in a digital transmission group, in accordance with MIL-STD-188-202.

5.2.2.2 <u>Layer 2</u>. Digital common-channel signaling messages shall be composed of 8-bit characters. The eighth bit of each message character shall be set to produce odd parity. These 8-bit characters shall be encoded into 16-bit blocks by employing the error detection and correction encoding described in TT-A3-9016-0056, the section titled *Trunk signaling message processing*.

5.2.2.3 <u>Layer 3</u>. Tactical common-channel signaling messages shall consist of a fixed number of fields, each comprised of one or more 8-bit characters. Each 8-bit character shall have 6 bits to carry trunk-signaling information. The other 2 bits shall be reserved for control and parity. Each message shall contain, as a minimum, a start-of-message field, a message-type field, a message-number field, an end-of-message field, and a message-parity field. Most messages have additional fields between the message-type field and the end-of-message field. The messages shall be composed in accordance with TT-A3-9016-0056, the section titled *Common channel signaling messages*.

5.2.3 <u>Wide-network interface to reference point B</u>. Same as ISDN base-level interface (see 5.2.1).

5.2.4 <u>Gateway functions</u>. The tactical, ISDN base level, and wide networks shall provide end-user to end-user service. The gateway function at reference point B shall provide signal conversion, as described in 5.2.4.1 to 5.2.4.4, to obtain interoperability between strategic and tactical subscribers.

5.2.4.1 <u>Circuit-switch-signaling message conversion</u>.
Interoperability between tactical circuit switches and ISDN
circuit switches shall be accomplished through appropriate
transformation of signaling messages at the gateway function
located at reference point B. The gateway function shall
translate out-of-band signaling messages between the tactical
circuit-switched network and ISDN switched networks for calls
initiated in either direction. Messages to and from the tactical
circuit-switched network side of the gateway function shall
comply with the digital common-channel signaling and supervision
paragraphs of TT-A3-9016-0056. Messages to and from the ISDN
side of the gateway function shall comply with ANSI T1.111,
T1.112, and T1.113, as described in mandatory Appendix D.
Messages shall be converted or translated by mapping information
in appropriate fields, as necessary, to support orderly call
initiation, connection, and release phases. Applicable messages
shall be returned and translated, as needed, because of busy
conditions, nonavailability of the called party, incompatible
terminals, security restrictions, or preemption. A typical call
initiation, connection, and release gateway signaling conversion
is shown in figures 5.2 and 5.3.

5.2.4.1.1 <u>Call initiation phase</u>. For calls originated in the
tactical circuit-switched network, tactical call-initiate
messages shall be forwarded to ISDN as initial address messages;
ISDN address-complete message replies shall be returned to the
tactical network as call-complete messages. For calls originated
in the ISDN, initial address messages shall be forwarded as
tactical call-initiate messages; tactical call-complete message
replies shall be returned as ISDN address-complete messages.

5.2.4.1.2 <u>Call connection phase</u>. For calls initiated in the
tactical network, ringback shall be returned to the originating
tactical network in the traffic channel, after the call complete
message has been returned in the signaling channel. Ringback
shall continue until the answer message is received from ISDN.
When the answer message is received, the traffic channel connects
through as a 64-kbps-ISDN-PCM to 16-kbps-tactical-CVSD channel
for nonsecure voice calls. For calls originated in ISDN,
ringback shall not be supplied by the gateway. The gateway
function shall monitor ringback in the traffic channel from the
tactical network; when ringback ceases, the gateway shall send an
answer message, in the signaling channel, to ISDN and shall
connect through the traffic channel as a 64-kbps-ISDN-PCM
to 16-kbps-tactical-CVSD channel for nonsecure voice calls. For
secure voice or data calls, the traffic channel shall be

connected through as a rate-adapted, 64-kbps-ISDN to 16-kbps-tactical channel.

5.2.4.1.3 <u>Call release phase</u>. For call disconnects originated in the tactical circuit-switched network, tactical release messages shall be forwarded as ISDN release messages; the ISDN release-complete message shall be returned as a tactical release-acknowledge message. For call disconnects originated in the ISDN network, the ISDN release message shall be forwarded as a tactical release message; the ISDN release-complete message shall be returned as a tactical release-acknowledgment message.
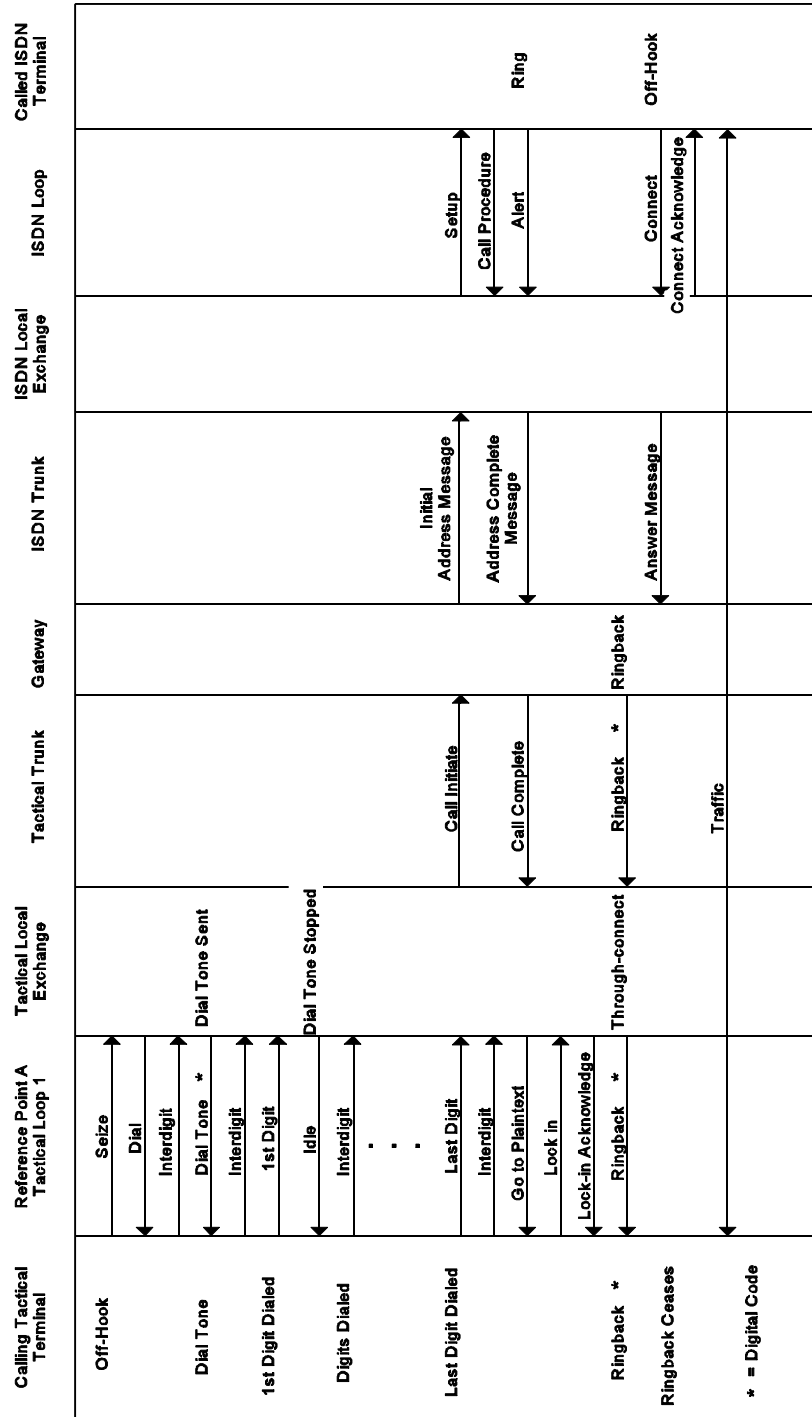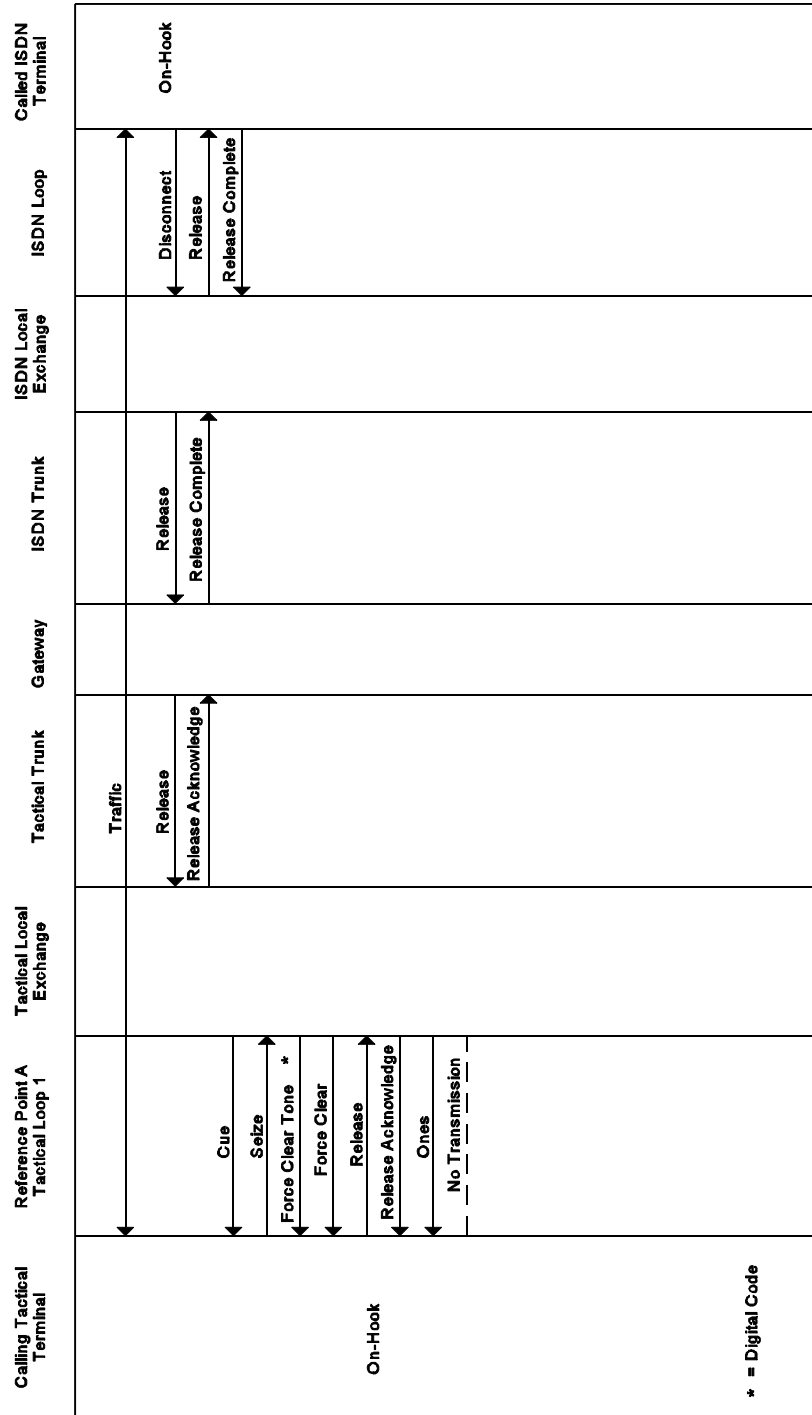
FIGURE 5.2. Call initiate and connection phase signalling.

FIGURE 5.3. Call Release Phase Signalling.

5.2.4.2 <u>Packet switching</u>. Tactical packet switches and ISDN packet switches shall comply with CCITT X.75 for connection mode service. They shall provide interoperability between host computers connected to tactical packet-switched networks and host computers connected to ISDN packet-switched networks. All switches requiring connectionless mode of service will comply with ISO DIS 10589 for IS-IS routing information exchange protocols.

5.2.4.3 <u>Voice telephony</u>. Tactical telephone subscribers shall be interoperable with ISDN telephone subscribers. Normally, this shall be accomplished by conversion between the tactical voice algorithm and the ISDN voice algorithm. See 4.1.5 for a description of ISDN and tactical voice algorithms. The gateway function shall provide the capability to achieve end-to-end secure voice calls by providing a transparent, bit-rate-adapted connection between compatible digital voice terminals as described in 4.1.6 and 4.1.7.

5.2.4.4 <u>Circuit-switched data</u>. The gateway function shall provide for the transfer of circuit-switched data between tactical subscribers and ISDN subscribers. The gateway function shall provide bit-rate adaption for ISDN B-channels in the manner described in 4.1.7, for standard bit rates up to 16 kbps.

5.3 <u>Standards for reference point B (NATO)</u>. This standard defines the standards applicable to the interface between U. S. network elements and NATO network elements.

5.3.1 <u>U.S.-wide-network to NATO interface</u>. The interface between U.S. strategic and NATO strategic circuit-switched networks shall comply with 5.3.1.1 to 5.3.1.3. The interface between U.S. strategic and NATO strategic packet-switched networks shall comply with STANAG 4263, Annex D (for layer 3), and STANAG 4262, Annex D (for layer 2).

5.3.1.1 <u>Layer 1</u>. The signal at reference point B (NATO) shall comply with the following parameters, as specified in CCITT Recommendation G.704.

    a.   Line code   HDB3.

    b.   BNZS   B4ZS in accordance with CCITT Recommendation G.703, the Annex titled *Definition of Codes*.

c. Bit rate   2.048 Mbps.

d. Number of channels   32, numbered from 0 to 31.
                                (Normally, 30 channels are
                                used as information-bearer
                                channels, 1 channel is
                                reserved for frame alignment,
                                and 1 channel is reserved for
                                common-channel signaling.)

e. Frame length   256 bits, numbered 1 to 256.

f. Frame repetition rate   8000 frames per second.

g. Frame alignment signal   0011011. The frame alignment
                                signal shall occupy positions
                                2 to 8 in time slot 0 of every
                                other frame. Bit 2 of time
                                slot 0, in frames not
                                containing the frame alignment
                                signal, shall be fixed at
                                logical one. (See figure
                                5.4.)

h. Frame alignment   See table IV.
    signal format

i. High-rate signals H_0=384 kbps.

j. Time-slot assignment   Time slot 16 shall be used to
                                transfer common-channel
                                signaling information (D-
                                channel), when it is present.
                                Time slots 1 to 15 and 17 to
                                31 are available for
                                allocation to other channels
                                (B or H_0). An H_0-channel may
                                be assigned any six time slots
                                in the frame, in numerical
                                order (not necessarily
                                consecutive).

Insert Figure 5-4

TABLE IV. Allocation of frame bits 1 to 8.

Bit number Alternate frames	1	2	3	4	5	6	7	8
Frame containing the frame alignment signal	Si	0	0	1	1	0	1	1
	Note 1	Frame alignment signal						
Frame not containing the frame alignment signal	Si	1	A	Sa4	Sa5	Sa6	Sa7	Sa8
	Note 1	Note 2	Note 3	Note 4				

Note 1 -- Si is the bit reserved for international use. If not used, this bit should be fixed at 1 on digital paths crossing an international border.

Note 2 -- This bit is fixed at 1 to assist in avoiding simulation of the frame alignment signal.

Note 3 -- A is the remote alarm indication. In undisturbed operation, it is set to 0; in alarm condition, it is set to 1.

Note 4 -- Sa4 to Sa8 are spare bits.

k.   Signaling data link   The signaling data link bit
                                    rate shall be 56 kbps,
                                    evolving to 64 kbps. Fifty-
                                    six kbps signals shall occupy
                                    bit positions 1, 2, 3, . . .,
                                    7 of the 64-kbps D-channel.
                                    The unused bit position shall
                                    be set to "1." The signaling
                                    data link shall be a
                                    bidirectional transmission
                                    path for common-channel
                                    signaling, comprising two
                                    "data channels" operating
                                    together in opposite
                                    directions at the same data
                                    rate. The signaling data link
                                    constitutes the lowest
                                    functional level (layer 1) in
                                    the SS7 functional hierarchy.
                                    SS7 shall be capable of
                                    operating over both
                                    terrestrial and satellite
                                    transmission links. The
                                    operational signaling data
                                    link shall be exclusively
                                    dedicated to the use of a SS7
                                    signaling link between two
                                    signaling points in SS7.

5.3.1.2 <u>Layer 2</u>. Layer 2 is the same as 5.2.1.2, except for the
signaling message structure. The standard routing label for
international signaling shall comply with CCITT Q.704, the
section titled *Routing label*. The routing label for
international calls shall consist of 14 bits for the destination
point code, 14 bits for the originating point code, and 4 bits
for the link selection code.

5.3.1.3 <u>Layer 3</u>. Layer 3 is the same as 5.2.1.3, except for
section 4 of ANSI T1.114. The ANSI standards in section 4 of
T1.114 include some minor variations from the international
standards. CCITT Recommendation Q.774 shall take precedence over
the national standard when signaling messages are exchanged over
international gateways.

5.3.2 <u>U.S.-tactical to NATO-tactical interface</u>. The interface
between U.S.-tactical and NATO-tactical circuit-switched networks

shall comply with STANAGs 4206 to 4212, 4214, and 4290. The interface between U.S.-tactical and NATO-tactical packet-switched networks shall comply with STANAG 4249.

5.3.3 <u>TCP/ISO gateway</u>. It is anticipated that U.S. end systems and networks will use data communications protocols based on MIL-STD-1777 and MIL-STD-1778 for a period of time after the ISO transport protocol is implemented in NATO. For this reason, a TCP-to-ISO protocol conversion capability shall be included at reference point B (NATO). This will allow the U.S. to comply with STANAG 4264 during the transition period where both TCP and ISO transport protocols must be accommodated. This approach has been described and published, and is provided in mandatory Appendix A. The TCP/ISO gateway approach shall be an interim measure until ESs achieve ISO compatibility as described in 5.4.2.

5.4 <u>Functional profiles</u>. The functional profiles described in 5.4.1 and 5.4.2 apply to host computers (end systems) that may be connected directly to a local-network element (reference point A) or to a gateway (intermediate system), which is then connected to a common-user network via reference point A (see figure 5.5). Data communications between end systems may cross-reference points A, B, and B (NATO). Data communications, which cross reference point B (NATO), between a U.S. end system and an end system of a NATO nation shall comply with all STANAGs applicable to layers 4-7 of the OSI reference model. The STANAG numbers are given in 5.4.1 and 5.4.2. The corresponding International Standardized Profile (ISP) classifications are provided. The document governing the preparation of ISPs is ISO/IEC TR 10000.
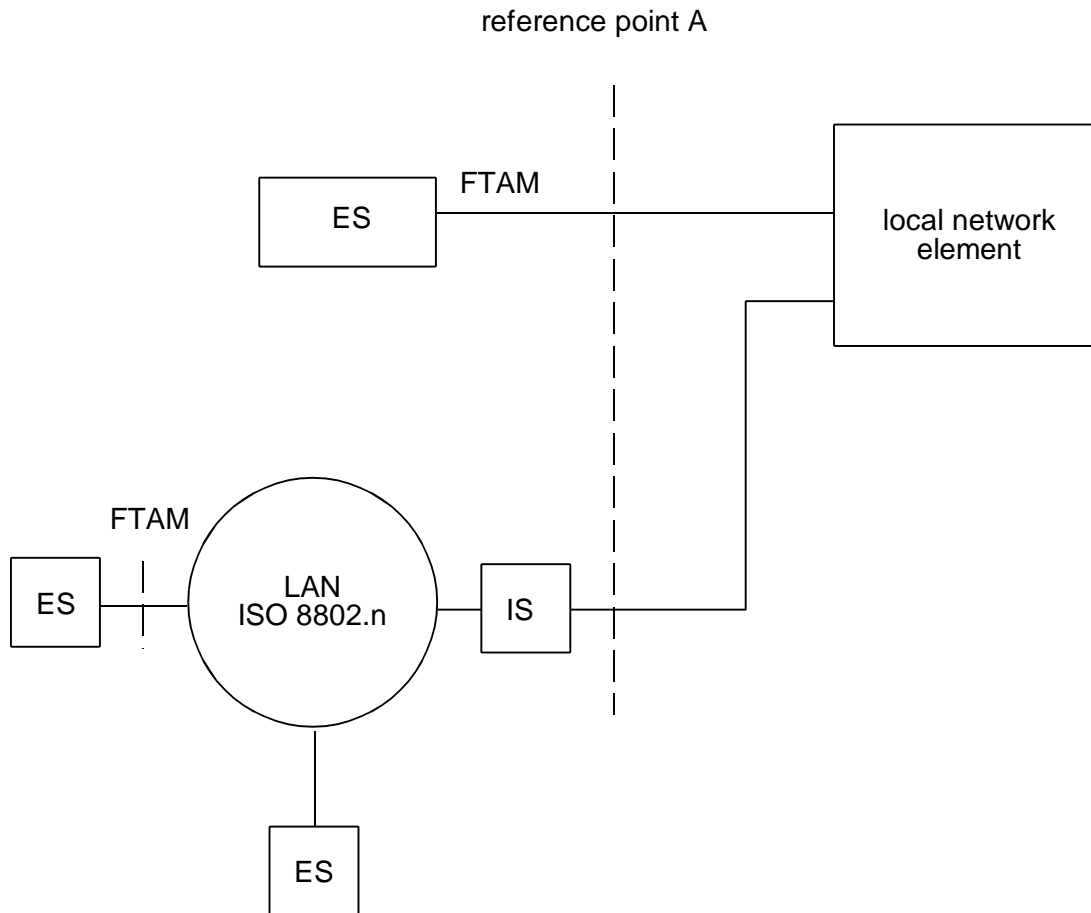
5.4.1 <u>Application profiles</u>. DoD application profiles use protocol standards from the ISO RM layers 5 through 7 to provide end-to-end information transfer. Sections 5.4.1.1 through 5.4.1.4 provide the application profiles for file transfer, access, and management (FTAM); for the message handling system (MHS); for directory service (DS); and for virtual terminals (VT). These functional profiles are used to ensure interoperability between DoD computers. Part 5 of NIST Special Publication 500-183 provides stable implementation agreements for protocols associated with the upper layers (4-7).

5.4.1.1 <u>File transfer, access, and management</u>. The FTAM application shall provide the capability to address, access, and manage the movement of information files among users. *File transfer* is the movement of a complete file between end systems.

File access is the reading, writing, or deleting of selected parts of a file residing on one end system by a user located at a remote end system. *File management* is the remote reading and altering of attributes that define a file. The ISPs for FTAM will be found in ISO ISP 10607 (6 parts). Two categories are defined: limited-purpose and full-purpose systems.

reference point A

```
        ┌──────┐   FTAM           │         ┌──────────────┐
        │  ES  │──────────────────│─────────│ local network│
        └──────┘                  │         │   element    │
                                  │         │              │
                                  │      ┌──│              │
     FTAM                         │      │  └──────────────┘
  ┌──────┐      ╱────────╲        │      │
  │  ES  │─────│   LAN    │─┌────┐│      │
  └──────┘     │ ISO 8802.n│ │ IS │──────┘
               ╲────────╱  └────┘│
                   │              │
                ┌──────┐
                │  ES  │
                └──────┘
```

LEGEND:

ES   = end system
IS   = intermediate system
n   = 3, 4, or 5
FTAM   =file transfer, access,
           and management
LAN   = local area network

FIGURE 5.5. Functional profiles.

5.4.1.1.1 <u>Limited-purpose system</u>. A limited-purpose system
shall implement, as a minimum, the following profiles:

ISP	DESCRIPTION
AFT 11	Simple File Transfer -- This profile shall enable users to read or write a complete file with unstructured text or a binary set.
AFT 3	Management -- This profile shall enable end-system users to manage files within the Virtual Filestore residing remotely.

5.4.1.1.2 <u>Full-purpose system</u>. A full-purpose system shall
implement, as a minimum, the following profiles:

ISP	DESCRIPTION
AFT 12	Positional File Transfer -- This profile shall enable users to read or write a single file access data unit or a complete file with sequential text, in addition to the capability provided by the AFT 11 profile. This profile shall be compatible with the Simple File Transfer (AFT11) for transfer of unstructured files.
AFT 21	Simple File Access -- This profile shall enable users to access files with unstructured text, sequential text, and an unstructured binary set.
AFT 3	Management -- This profile shall enable end-system users to manage files within the Virtual Filestore residing remotely.

5.4.1.1.3 <u>Virtual filestore</u>. FTAM protocol and service
definitions shall allow users on different end systems to modify
and transfer files without requiring that one user know the
detailed file characteristics of the other user. This shall be
accomplished by defining Virtual Filestore, which is used for
communications between end systems and is mapped to corresponding
elements of the local file system residing in an end system. The
mapping between the real file and the virtual file, with its file

access structure, is performed by the local FTAM agent. Virtual Filestore is defined in ISO 8571-2. Virtual Filestore shall be defined by the attributes defined in 5.4.1.1.3.1 and 5.4.1.1.3.2.

5.4.1.1.3.1 <u>File attributes</u>. The file attributes represent a file as it is actually stored and shall consist of the following:

● File name	● Permitted actions	● Access control
● Storage account	● File availability	● Contents type
● Encryption name	● File size	● Future file size
● Legal qualification	● Private use	

Date and time of:
- ● Creation
- ● Last modification
- ● Last read access
- ● Last attribute modification

Identity of:
- ● Creator
- ● Last modifier
- ● Last reader
- ● Last attribute modifier

5.4.1.1.3.2 <u>Activity attributes</u>. The activity attributes shall occur only while an FTAM dialog is in progress. They are of no relevance to an end system and its real file outside of such a dialog. The activity attributes shall consist of the following:

a.   Current access request

b.   Current initiator identity

c.   Current access passwords

d.   Current calling application entity title

e.   Current account

f.   Current responding application entity title

g.   Current access context

h.   Current concurrency control

i.   Current location

j.   Current processing mode

5.4.1.1.4 <u>Application layer</u>.   The FTAM functional profiles shall be supported at the application layer by the following base standards:

ISO 8613 Office Document Architecture (ODA)

ISO 8571 FTAM

ISO 8650 Association Control Service Elements (ACSE)

5.4.1.1.4.1 <u>Office document architecture</u>. ISO 8613 (Parts 1, 2, and 4 to 8) specifies rules for describing the logical and layout structures of documents. It also specifies the rules for character, raster, and geometric content of documents so that complex documents can be interchanged. Since the functional profiles addressed are limited to files with unstructured text, sequential text, and an unstructured binary set, no further discussion is provided for ODA at this time.

5.4.1.1.4.2. <u>FTAM service elements</u>. The services offered are defined in ISO 8571-3. The part of a protocol concerned with the realization of a particular service is a service element. FTAM offers a file service provided by a considerable number of service elements. Association between peer FTAM processes shall be achieved by the use of ACSE (see 5.4.1.1.4.3). Once an FTAM association has been established, the function determines the FTAM operational environment that is to exist over the association. Table V provides the relationship between FTAM functions, profiles, services, and associated service elements. These protocol specifications shall define the formats and parameters of the control messages, and the actions to be taken by the peer entity on receiving a control message or a user's service request. The protocol specification offered can be found in ISO 8571-4. Parts 9 and 10 of NIST Special Publication

500-183 provides stable implementation agreements for FTAM protocols. The FTAM service elements are grouped into functional units that support FTAM.

5.4.1.1.4.3 <u>Association control service elements</u>. The FTAM shall use ACSEs that are required by all application standards but that do not depend on the specific nature of the application that is standardized. ISOs 8649 and 8650 define these service elements and protocol standards. The services in the association category shall include the following: application association establish, application association release (orderly release), and application association abort (disorderly release).

TABLE V. Relationship between FTAM functions and service classes.

FUNCTION	PROFILE				SERVICE	SERVICE ELEMENT
	AFT11	AFT12	AFT21	AFT3		
Kernel	M	M	M	M	• Establish regime • Release orderly regime • Release disorderly regime • Select file • Deselect file	• F-INITIALIZE • F-TERMINATE • F-ABORT • F-SELECT • F-DESELECT
Read	M	M	M	--	• Read bulk data • Transfer data unit • End data transfer • End transfer • Cancel data transfer • Open file • Close file	• F-READ • F-DATA • F-DATA-END • F-TRANSFER-END • F-CANCEL • F-OPEN • F-CLOSE
Write	M	M	M	--	• Write bulk data • Transfer data unit • End data transfer • End transfer • Cancel data transfer • Open file • Close file	• F-WRITE • F-DATA • F-DATA-END • F-TRANSFER-END • F-CANCEL • F-OPEN • F-CLOSE
File Access	--	--	M	--	• Locate • Erase	• F-LOCATE • F-ERASE
File Management	--	--	--	M	• Create file • Delete file • Read attributes • Change attributes	• F-CREATE • F-DELETE • F-READ-ATTRIB • F-CHANGE-ATTRIB
Recovery	O	O	O	--	• Recover regime • Insert check point • Cancel data transfer	• F-RECOVERY • F-CHECK • F-CANCEL
Restart Data Transfer	O	O	O	--	• Restart data transfer • Insert check point • Cancel data transfer	• F-RESTART • F-CHECK • F-CANCEL

NOTES:

M = mandatory; O = optional; -- = not available.

5.4.1.1.5 <u>Presentation layer</u>. This layer is associated with presentation issues over a session connection and is defined in ISO 8823. STANAG 4256 contains a provision to satisfy NATO military requirements for OSI RM presentation layer service, and STANAG 4266 discusses the provision for the basic NATO military features for the presentation layer protocol. With the interconnection of heterogeneous systems, it is assumed that the service coding is not necessarily the same at both systems.

5.4.1.1.5.1 <u>Abstract syntax</u>.   The FTAM presentation entities shall exchange abstract syntax in a precise representational form understood by peer entities for the following abstract syntaxes:

   a.   ISO FTAM unstructured text (FTAM-1)

   b.   ISO FTAM sequential text (FTAM-2)

   c.   ISO FTAM unstructured binary set (FTAM-3)

The abstract syntax is formally defined in ISO 8824, Abstract Syntax Notation 1 (ASN.1), without reference to the use of any encoding technique. The transfer syntax defines the order in which the bytes shall be physically transmitted to include information encryption requirements, compression of recurrent information, or both. Transfer syntax is derived by applying the basic encoding rules for ASN.1 to the abstract syntax defined in ISO 8825 and STANAG 4259. A pairing of abstract and transfer syntax, known as presentation context, shall be successfully negotiated between peer presentation entities. The list of negotiated presentation contexts is known as the defined context set.

5.4.1.1.5.2 <u>Presentation services</u>. The presentation services shall comply with ISO 8822 and shall be limited to the kernel portion, which is related to connection establishment and release, and to application information transfer services. STANAG 4266 contains provisions to satisfy NATO's military requirement for the OSI RM presentation layer.

5.4.1.1.6 <u>Session layer</u>. The session layer protocol defined in ISO 8327 and service elements are defined in ISO 8326. STANAG 4255 contains a provision to satisfy NATO military requirements for OSI RM session layer service, and STANAG 4265 discusses the provision for the basic NATO military features for the session layer protocols. This layer, defined in ISO 8327, is associated

with data transfer, control, and management services over a session connection. The intelligence behind the control of session services lies with the peer application processes. They shall access the session services by use of mirrored services provided through the presentation layer. For the FTAM to function over a session connection, the following functional units shall be available at this layer: kernel, resynchronization, and minor synchronization.

5.4.1.1.6.1 <u>Kernel</u>. The kernel functional unit supports the basic session services of connection establishment, normal data transfer, and connection release.

5.4.1.1.6.2 <u>Resynchronization</u>. The resynchronization function shall be used when a session user determines the information exchange is unreliable and requests that information transfer restarts at a mutually agreed point: synchronization point serial number. This service originated at the application layer (F-CANCEL) and mirrored through the presentation layer (P-RESYNCHRONIZE). On issuing this request, the application processor shall not invoke any further session service, other than a disorderly termination (F-ABORT), until such time as the confirmation has been received.

5.4.1.1.6.3 <u>Minor synchronization</u>. Minor synchronization points are used to establish commonly understood points in the information exchange within a dialog unit. The FTAM check point service shall be used to provide either the recovery or restart function. The F-CHECK service element shall provide a facility for FTAM to insert check points into the flow of data. The presentation layer mirrors this service element (P-MINOR-SYNC) and becomes S-MINOR-SYNC at the session layer.

5.4.1.2 <u>Military Message-Handling System (MMHS)</u>. The MMHS application profile addresses store and forward electronic messaging between network users. The MMHS is defined in STANAG 4406 and is based on the CCITT Recommendation X.400.

5.4.1.2.1 <u>Military Messaging Service (MMS)</u>. The MMS is similar to the Interpersonal Message Service (IPMS) defined in civilian standards, but includes extensions for services required in the military environment. The vendor shall provide an MMS in accordance with STANAG 4406. The content-type used for the MMS is P772 (IPMS uses P22).

5.4.1.2.2 <u>Electronic Data Interchange (EDI) service</u>. The vendor
shall provide EDI service in accordance with CCITT Recommendation
X.435 and applicable portions of NIST Special Publication 500-183
(Stable Implementation Agreements).

5.4.1.3 <u>Directory services</u>. DS is specified in CCITT
Recommendation X.500 (Blue Book, 1988). FIPS 146 Version 3 is
expected to address X.500. Part 11 of NIST Special Publication
500-183 provides stable implementation agreements for DS
protocols. The ISP for DS will comply with the profile
classification ADIn, as indicated below:

ADIn	APPLICABLE STANDARDS
Layer 7	CCITT X.500 ISO 8650 Association Control Service Element (5.4.1.1.4.3)
Layer 6	ISO 8823 Connection-oriented Presentation Protocol (5.4.1.1.5)
Layer 5	ISO 8327 Connection-oriented Session Protocol (5.4.1.1.6)

5.4.1.4 <u>Virtual terminal</u>. VT application profiles allow
terminals and hosts on different networks to communicate without
the hosts having knowledge of specific terminal characteristics.
Part 14 of NIST Special Publication 500-183 provides stable
implementation agreements of VT protocols. Two categories are
defined:

   a.   Simple System -- A teletype (TTY)-compatible device
that uses a simple line or character at a time and controls
characters from the American Standard Code for Information
Interchange (ASCII) character set. A simple system supporting the
TELNET profile requires the asynchronous mode (A-mode) of
operation, as indicated below:

ISP	DESCRIPTION	
AVT12	Mode A; TELNET	MIL-STD-1782
AVT13	Mode A; Line Scroll	FIPS 146 Version 3
AVT14	Mode A; Paged	FIPS 146 Version 3

b.   Forms Capable System -- Supports forms-based
applications with local entry and validation of data by the
terminal system. Some of the functions supported are cursor
movement, erase screen, and field protection. The forms profile
requires the synchronous mode (S-mode) of operation and specifies
simple delivery control. A forms-capable system shall support
both the forms profile specified in section 14.8.3 of the
Workshop Agreements and the TELNET profile defined in MIL-
STD-1782. The corresponding Workshop Agreements with FIPS 146,
Version 2, limits the forms-capable system to the A-mode. The S-

mode should be addressed when the FIPS 146, Version 3, is released. The applicable standards are shown below:

AVT2n	APPLICABLE STANDARDS
Layer 7	ISO 9040 VT ISO 8650 Association Control Service Element (5.4.1.1.4.3) ISO XXXX Remote Operations Service Element (ROSE)
Layer 6	ISO 8823 Connection-oriented Presentation Protocol (5.4.1.1.5)
Layer 5	ISO 8327 Connection-oriented Session Protocol (5.4.1.1.6)

5.4.2 Transport profiles. Transport profiles identify the use of base standards for OSI RM layers 1 through 4 to provide information transfer between transport entities. The transport profiles are limited to providing connection-oriented transport service (COTS) (see 5.4.2.1). COTS may be supported by either a connectionless network, (see 5.4.2.2.2) or a connection-oriented network (see 5.4.2.2.3). To meet the evolutionary requirement for existing DoD network protocols, ESs shall emulate the transport service described in 5.4.2.1.1, using the end-to-end service of the internet protocol suite. The approach taken shall be based on the RFC 1006 method (see mandatory Appendix B) to treat the transmission control protocol (TCP), which is a connection-oriented, stream-based, transport protocol, as though it were actually offering a connection-oriented network service. RFC 1086 supplements RFC 1006 and is contained in Appendix C. This approach shall be used only on an interim basis until GOSIP is fully implemented.

5.4.2.1 Connection-oriented transport service. COTS implies that although the internal operation of a network is based on packets, to the end user the network is indistinguishable from a full-period, end-to-end system. The packetized operation must be essentially invisible to the user, with data coming out of the network in exactly the same sequence it went into the network.

5.4.2.1.1 Transport service. The transport service, as defined in ISO 8072, shall move data reliably from one end system to another. STANAG 4254 contains provisions to satisfy NATO military requirements for transport layer service. The transport service is in one of three phases at any one time: transport

connect (TC) establishment, data transfer, and transport connection release.

5.4.2.1.2 <u>Transport protocols</u>. Based on the available network service, five different COTS protocols exist. These are termed Transport Protocol (TP) Classes 0 through 4 (TP0-TP4). For GOSIP end-systems, COTS, as provided by TP4, is mandatory, except when the end system is also connected to public messaging domains conforming to CCITT Recommendation X.410 (Red Book). Then it must be capable of using TP0 when acting as a messaging relay between the two domains. A detailed description of the structure and encoding of these transport protocol data units (TPDU) can be found in CCITT Recommendation X.224, the section titled *Structure and Encoding of TPDUs*, or ISO 8073. STANAG 4264 discusses the provision for the basic NATO military features for the transport layer protocol. Part 4 of NIST Special Publication 500-183 provides stable implementation agreements for TPDUs. All unknown parameters in a TPDU shall be ignored. Known parameters with valid lengths but with invalid values shall be handled as follows:

a. Parameter	Action
● transport service	
● access point (TSAP) identifier	● Send T-DISCONNECT
● TPDU size	● ignore parameter; use default
● version	● ignore parameter; use default
● checksum	● discard
b. Alternate Protocol	
● Class	● Protocol error

5.4.2.1.3 <u>Security protocol</u>. The end-to-end security protocol shall be as defined by NIST IR 90-4250. The NIST IR 90-4250 submitted to ANSI for adoption shall be used to define the end-to-end security protocol at the transport layer. This security protocol encapsulates the TPDU, but first, it adds an integrity code if integrity is required, encrypts the entire TPDU if confidentiality is required, and then puts the result in a secure

encapsulation of the TPDU. A receiver that has the correct cryptographic key shall be able to decrypt the secure encapsulation of the TPDU, to verify its integrity and then process the resulting TPDU.

5.4.2.2 Supporting networks. COTS shall be supported by either a connectionless network that provides Connectionless Network Service (CLNS) or a connection-oriented network (see 5.4.2.2.3) that provides Connection-Oriented Network Service (CONS) and shall have a common network addressing structure (see 5.4.2.2.1).

5.4.2.2.1 Network addressing. The second addendum to the network service, ISO 8348, defines network layer addressing. To maintain the transparent goals of the OSI RM, a network address makes no implications about the physical location of a node; nor does a network address contain explicit routing information. The OSI strategy is to use a hierarchically structured address. At the top level, an address shall be divided into two parts: an initial domain part (IDP) assigned by the ISO/IEC, and a domain specific part (DSP). The IDP is further subdivided into two parts: the authority and format identifier (AFI) and the initial domain identifier (IDI). Table VI provides the AFI values assigned by ISO/IEC as a function of the IDI format. The AFI values are a function of the DSP syntax indicating either decimal or binary. The maximum IDP length in digits is also provided.

TABLE VI. AFI values.

IDI FORMAT	AFI VALUE DSP SYNTAX		IDP MAXIMUM LENGTH
	DECIMAL	BINARY	
CCITT X.121	36, 52	37, 53	16
ISO 3166 DCC	38	39	5
CCITT F.69	40, 54	41, 55	10
CCITT E.163	42, 56	43, 57	14
CCITT E.164	44, 58	45, 59	17
ISO 6523 ICD	46	47	6
NON-ALIGNED	48	49	2

The ISO/IEC assigned the international code designator (ICD) to NIST and the data country code (DCC) to ANSI. The System and Network Architecture Division at NIST determines how Government agency-specific identifications are assigned and registered at the national level. NIST has delegated the management responsibility to the Telecommunications Customer Service Division within the General Service Administration (GSA). Presently, the GSA is defining the registration procedures as well as usage guidelines. The AFI value of decimal 47 specifies that the IDI part is interpreted as a four-decimal-digit ICD and that the DSP has a binary abstract syntax. The IDI, set to 5 for the entire Federal Government's use, including DoD and the DSP address structure, is defined in FIPS 146-1, section 5.1.1. NIST applied for and obtained an ICD equal to 6 for DoD use. The DSP is presently undefined.

5.4.2.2.2 <u>Connectionless network</u>. A connectionless network is one in which a service can be requested at any time there is no requirement for a direct connection between users. Since no connection exists between users, the network address shall be included explicitly with every transfer request. Wide-area networks, such as the Defense Data Network (DDN), use internetwork protocols (see 5.4.2) to provide connectionless network service. Most of the commercially available connectionless networks are configured within a localized geographical area known as a LAN. These LANs are often capable of transmitting data at very high rates, up to 10 Mbps. This is made possible by the fact that the physical medium is installed between systems located in close proximity.   The ISPs for COTS over CLNS will be found in ISO ISP 10608 (Parts 1, 2, and 5). GOSIP, Version 2, mandates that connectionless network service be provided to Government users.

5.4.2.2.2.1 <u>Network service</u>. Connectionless network services are defined in addendum 1 to the Network Service Definition Standard, ISO 8348.

5.4.2.2.2.2 <u>Network protocols</u>. Protocol combinations to provide connectionless network service are defined in ISO 8880, Appendix 3. To offer connectionless network service, ISO 8880, Appendix 3, identifies the protocols used to implement the connectionless network protocols found in ISO 8473. ISO 8473, Addendum 3, specifies the provisions of the underlying service over a subnetwork that provides the OSI data link service.   Part 3 of

NIST Special Publication 500-183 provides stable implementation agreements for network protocols. When an end system is connected to a local-area or point-to-point subnetwork, the end system to intermediate system dynamic routing protocol, as defined in ISO 9542, shall be used. This protocol is limited to addressing the routing between end systems and intermediate systems on the same or directly connected subnetworks. (Intermediate system to intermediate system dynamic routing protocols shall comply with ISO DIS 10589 after approval. Implementation of the security option shall require the assignment of new parameter values to the Reason for Discard parameter in the error reporting, as defined in FIPS 146-1. The NIST IR 90-4250 SP3 (submitted to ANSI for adoption) shall be used to define the security option at the network layer. This standard shall be implemented in intermediate gateway systems, as well as end systems. The security protocol encapsulates the TPDU, but first adds network addresses to the protocol header for network routing, adds an integrated code if integrity is required, encrypts the entire TPDU if required, and then puts the result in a secure encapsulation of the TPDU.

5.4.2.2.2.3 <u>Link service</u>. The link service provided over a LAN shall be a Type-1 connectionless network service. The link layer of the OSI RM shall be divided into two sublayers. The logical link control (LLC) shall establish, maintain, and terminate the logical link between devices, and the media access control (MAC) shall regulate access to the medium. Part 2 of NIST Special Publication 500-183 provides stable implementation agreements for protocols related to subnetworks.

5.4.2.2.2.3.1 <u>Logical link control</u>. For LANs, the LLC shall comply with ISO 8802-2 to provide a connectionless subnetwork service to support connectionless network protocols. The LLC shall be used to maintain the logical link between devices. The LLC generates command packets (or frames) called protocol data units, and interprets them. The unacknowledged connectionless service shall allow the network entities to exchange link service data units without a data-link level connection. The data transfer can be point-to-point, multicast, or broadcast.

5.4.2.2.2.3.2 <u>Media access control</u>. The MAC in LANs deals with the methods for allowing a particular node to transmit on the data transmission channel available to it. A LAN can be configured as either a bus or a ring topology. Furthermore, two primary methods are used to control access: carrier sense multiple access/collision detection (CSMA/CD) and token passing.

The IEEE 802 Committee on LAN and the ISO community have followed
with corresponding ISO 8802 series standards that address media
control and physical layers. The ISO 8802-3 standard addresses
CSMA/CD, ISO 8802-4 addresses token-passing buses, ISO 8802-5
addresses token-passing ring buses, and ISO 9314 addresses FDDI.

5.4.2.2.3 <u>Connection-oriented network</u>. A connection-oriented
network is based on the ability to reserve a path through a
network for the duration of the network connection. Based on
FIPS 146-1, an end-system shall be directly connected to a
connection-oriented network only when the network is an CCITT
X.25 wide-area network or an ISDN wide-area network. The ISPs
for COTS over CONS will be found in ISO ISP 10609 (9 parts).

5.4.2.2.3.1 <u>Network service</u>. The network service for a
connection network is defined in ISO 8348. STANAG 4253 contains
provisions to satisfy NATO's military requirements for OSI RM
network layer service. The network service is in one of three
phases at any one time: connection establishment, data transfer,
and connection release.

5.4.2.2.3.2 <u>Network protocols</u>. Protocol combinations to provide
connection network service shall be defined in ISO 8880, Appendix
2. To offer the connection network service, ISO 8880, Appendix
2, identifies the protocols used to realize the CCITT X.25
packet-layer protocol (PLP) over the subnetwork. ISO 8878
defines the use of CCITT X.25 PLP to provide the OSI connection
network service. ISO 8208 defines the packet format and control
procedures for the exchange of packets that contain control
information and user data at data terminal equipment. ISO 8208,
Addendum 2, defines the dial-up access to a packet-switched
public data network through a public switched telephone network
(PSTN), an integrated-services digital network, or a circuit-
switched public data network. CCITT Q.931 defines additional
signaling requirements during set-up of an incoming call when D-
channel access is required on the ISDN. Part 3 of NIST Special
Publication 500-183 provides stable implementation agreements for
network protocols. STANAG 4263 contains the military features
required for NATO's network layer protocols.

5.4.2.2.3.3 <u>Data link service</u>. Data link service for a
connection network is defined in ISO 8886. STANAG 4252 contains
provisions to satisfy NATO's military requirements for OSI RM
data-link layer service. The data link service is in one of
three phases at any one time: connection establishment, data
transfer, and connection release.

5.4.2.2.3.4 <u>Data link protocols</u>. End systems that are directly
connected or use dial-up access to the packet-switched public
network shall use the LAPB protocol, except for connection to the
ISDN D-channel. For access via the ISDN D-channel, the LAPD
protocol shall be used as defined in CCITT Q.921. The LAPD
protocol is a fully standard implementation of the ISO High-level
Data Link Control (HDLC) protocol and can be found in the
following documents: ISO 7809, ISO 4335, ISO 3309, ISO 8471, and
ISO 8885. Part 2 of NIST Special Publication 500-183 provides
stable implementation for protocols related to subnetworks.
STANAG 4262 contains the military features required for NATO's
data-link layer protocols.

5.4.2.2.3.5 <u>Physical layer</u>. FIPS 146-1 does not mandate any specific physical interface except for ISDN. For non-ISDN application, or for the R interface of ISDN applications using terminal adapters, MIL-STD-188-114 shall be used for the physical layer interface. MIL-STD-188-114 is based on EIA 422 and 423 and is interoperable with EIA 232 (formerly RS-232), and the CCITT V.35 digital interface referenced in GOSIP FIPS 146. For ISDN, FIPS 146, Version 2, mandates that for the basic rate interface (BRI) at the S and T reference points, ANSI T1-605-1988 shall be used. STANAG 4251 contains provisions to satisfy NATO's military requirements for OSI RM physical layer service, and STANAG 4261 contains the military features for NATO's physical layer protocols.

5.5 <u>Subscriber network elements</u>. General requirements for subscriber network elements are listed in 4.5.2.1. The implementation of narrowband ISDN and in the future broadband ISDN requires a substantial investment in the upgrade of DIS. To take advantage of DIS features requires direct digital capabilities be provided to all subscriber network elements. These subscriber elements are discussed on the basis of their access requirements: direct, mobile, universal, and indirect.

5.5.1 <u>Direct access</u>. Direct access can be provided by copper wire, coaxial cable, or fiber optical cable. The access method depends on the bandwidth that must be supported. This entails developing all-digital subscriber-terminal equipment with direct access that can provide voice, high-speed communications of data; facsimile (text and graphics); still and motion video communications; as well as broadcast of high-resolution television.

5.5.1.1 <u>Voice</u>. All voice end terminals shall provide voice digitization. Strategic subscriber terminals shall use 64-kbps PCM or 32-kbps ADPCM. Tactical subscriber terminals shall have the capability to interface, either directly or via a switch, using 16-kbps CVSD analog-to-digital (A-D) conversion as defined in MIL-STD-188-113. Voice terminals employing CELP shall be capable of providing 4.8-kbps CELP A-D conversion as defined in FED-STD 1016. The voice digitization algorithm shall be negotiated during call set-up and the 4.8-kbps CELP shall be the preferred mode. Military satellite (in the anti-jam mode) and HF radio applications shall use 2.4-kbps LPC.

5.5.1.2 <u>Data</u>. All end terminals that provide data communications shall be capable of supporting all application profiles, as defined in 5.4.1.

5.5.1.3 <u>Facsimile</u>. All end terminals that provide text and graphics in the form of facsimile shall conform to MIL-STD-188-161.

5.5.1.4 <u>Video</u>. All end terminals that provide motion video conferencing shall conform to MIL-STD-188-131, which is being written to comply with the P times 64 standard described in CCITT H.320. All end terminals that provide still graphics video conferencing shall conform to MIL-STD-188-132, which is being developed to conform to the commercial standard being sponsored by DoD in the EIA TR29 Facsimile Committee.

5.5.1.5 <u>High-definition television</u>. High-definition television (HDTV) standards are under development for end terminals that provide the HDTV function.

5.5.2 <u>Mobile access</u>. Due to rapid advances in signal processing and integrated circuit technology, digital radio has become viable technology for implementing wireless subscriber loop service in remote rural areas; for providing wireless private branch exchange (PBX) service; for cellular digital mobile radio service; for digital mobile satellite service; and for tactical digital radio network service. All subscriber network elements requiring mobile access shall have a default voice algorithm of 4.8-kbps CELP, and the gateway function at reference point A shall allow for data traffic with bit count integrity to support both secure voice and data. Standards for mobile access are under development. NSA has been leading the Government effort to create standards within industry that support interoperable data communications via mobile subscriber interface and control, and network interface and control.

5.5.2.1 <u>Wireless subscriber loop service</u>. Standards for remote wireless subscriber loop service are under development.

5.5.2.2 <u>Wireless PBX service</u>. New low-power, short-range digital radio (average transmitter power in the order of 10 mW) technologies are being developed. The use of digital multiplexing with demand assignment access of digital radio links could service multiple user terminals. Time-division multiple access (TDMA) standards for cellular digital mobile radio service

(see 5.5.2.3) may also be viable for multiple user indoor application.

5.5.2.3 <u>Cellular digital mobile radio service</u>. Standards are being developed for next-generation digital cellular mobile radio systems. [The Special Mobile Group (GSM) of the European Telecommunications Standards Institute (ETSI) is standardizing a pan-European TDMA mobile radio technology. The Telecommunications Industry Association (TIA) and Cellular TIA (CTIA) are standardizing an entirely different TDMA technology for North America. It is expected that these two efforts will converge to enhance interoperability.]

5.5.2.4 <u>Digital mobile satellite service</u>. Digital mobile satellite service will be based on Ultra Small Aperture Terminal (USAT) technology with a 10 to 12-inch antenna diameter. USAT requires very complex hybrid spread-spectrum modulation and access techniques to limit interference. The information rate is limited to 2.4 kbps, ruling out the use of the default 4.8-kbps CELP voice algorithm for this service. Standards will be developed for end terminals requiring service over digital mobile satellite links.

5.5.2.5 <u>Tactical digital radio network service</u>. Standards for HF radio subsystems are listed in 4.4.2.7. Standards for HF radio subscriber networks are under development. Planning standards for HF will be contained in MIL-STD-187-721. HF radio automatic link establishment (ALE) shall comply with FED-STD-1045. Standards for automatic HF radio networking will be contained in FED-STD-1046. Standards for HF store-and-forward service will be contained in FED-STD-1047. Standards for automatic HF networking to multiple transmission media will be contained in FED-STD-1048. Standards for HF radio automatic operation in stressed environments will be contained in FED-STD-1049.

5.5.3 <u>Universal access</u>. Universal access will allow subscribers to initiate and receive calls through the DIS irrespective of their geographical location. Two basic concepts related to universal access are emerging: the mobile communication facility offered by the Universal Mobile Telecommunications System (UMTS), and the personal communication facility offered by the Personal Telecommunications Service (PTS). Standards for universal access are under development.

5.5.3.1 <u>Universal mobile telecommunications system</u>. The UMTS shall provide mobile communications, not only by keeping track of the location of the mobile subscriber (by storing information about their current location), but also by maintaining ongoing calls and connection, despite their movement.

5.5.3.2 <u>Personal telecommunications service</u>. The PTS shall be provided across multiple networks and allows network-independent user identification. From a network point of view, the PTS may be based on either wired or wireless interface.

5.5.4 <u>Indirect access</u>. End terminals can be configured on a LAN or a group of LANs that are joined by bridges to form an extended LAN.

5.5.4.1 <u>Local area network</u>. End terminals configured to a LAN at the network layer shall use connectionless network protocols, as defined in ISO 8473, and at the link layer shall use logical link control type-1, as defined in ISO 8802-2. End terminals at the MAC level that require: carrier sense multiple access shall conform to ISO 8802-3. End terminals at the MAC level that require token passing bus access shall conform to ISO 8802-4. End terminals at the MAC level that require token-passing ring-bus access shall conform to ISO 8802-5. End terminals at the MAC level that require FDDI shall conform to ISO 9314. The IEEE has developed an IEEE Standard 802.6, *Distributed Queue Dual Bus (DQDB) Subnet of a Metropolitan Area Network (MAN)*, which will eventually be adapted as an ISO 8802-6 standard. End terminals at the MAC level that require broadband service (see 5.6) via MAN shall conform to ISO 8802-6. Wireless LANs are a subject for further study.

5.5.4.2 <u>Bridges</u>. A bridge connects data links for the purpose of forwarding packets between local networks. A bridge operates at the logical link or MAC layer (level 2 of the ISO RM), independent of higher-level protocols. A bridge architecture can be based on either a transparent spanning tree or on source routing.

5.5.4.2.1 <u>Transparent-spanning-tree bridge</u>. A transparent-spanning-tree bridge shall modify its address table dynamically for each packet it receives. If a station address is unknown, the bridge shall flood all links other than the link over which the packet was received. A transparent-spanning-tree bridge can function as either a local or remote MAC bridge. A local bridge is directly connected to LANs and shall conform to IEEE 802.1D.

A remote bridge is directly attached to one or more LANs, and also on unspecified interconnection medium and will conform to draft standard IEEE P802.1G/1D. The MAC frame is encapsulated within the appropriate interconnecting medium for transmission across the network to a peer remote bridge.

5.5.4.2.2 <u>Source routing bridge</u>. In a source routing bridge the route shall be determined by the source station for each frame sent through one or more bridges to the destination station. The routing information is contained within each frame and used by each bridge it transitions over. Source routing information shall be acquired by the originating station by broadcasting a request that is updated by each bridge it transitions over. Multiple copies that are received by the destination station are sent back to the originating station, and the information is used to select the preferred path. A source routing bridge shall conform to ISO 8802-5.

5.6 <u>Broadband service support</u>. Broadband service support within the DIS shall pertain to network interface transport rates, formats, and architectures associated with digital hierarchies defined in ANSI T1.105, CCITT Recommendations G.707 and I.121, and IEEE 802.6.

5.6.1 <u>The transport digital hierarchy</u>. In support of broadband services, two primary digital hierarchy standards are applicable: ANSI T1.105 and CCITT Recommendation G.707. Within CONUS, the ANSI T1.105 Digital Hierarchy Optical Interface Rates and Formats Specification, commonly referred to as SONET, defines the layer 1 Synchronous Optical Hierarchy (SOH). CCITT Recommendations G.707 through G.709 define the layer 1 Synchronous Digital Hierarchy (SDH) for international use. Where common rates and formats exist, the SONET standard is functionally and structurally equivalent to CCITT Recommendation G.707.

5.6.1.1 <u>Synchronous Optical Network</u>. The primary objective of SONET is the definition of a SOH with sufficient flexibility to support transmission rates and formatted signals. Any signal transmitted using ANSI T1.105 shall employ ANSI T1.106 to provide opto-electrical conversion.

5.6.1.1.1 <u>Rates</u>. Where necessary, support of various low transmission rates across a high-rate connection shall be accomplished through the employment of synchronous multiplexing. Multiplexing results in a family of standard rates and formats, which are multiples of the basic 51.84-Mbps Synchronous Transport

Signal 1 (STS-1) rate. To support broadband services, basic rate
signals shall be time-division multiplexed to build higher
transmission rates. SONET shall support sub-STS-1 rate signals
by multiplexing these lower rate signals in accordance with ANSI
T1.105. The SONET rates applicable to the DIS are listed in
table VII.

TABLE VII. <u>SONET rates (Mbps)</u>.

STS-1	51.840
STS-3	155.520
STS-12	622.080
STS-24	1244.160
STS-48	2488.320

NOTE:

STS-M = Synchronous Transport Signal M.
Optical Carrier Level-M (OC-M) is the optical
equivalent to STS-M.

5.6.1.1.2 <u>Frame format</u>. Figure 5.6 depicts the STS-M frame
structure. For M=3, each of nine rows of the STS-1 frame
consists of 9 octets of overhead and 261 octets of user traffic
payload.

9 Rows

87 x M octets

3 x M

STS-M Synchronous
Payload Envelope (SPE)

Overhead
Field
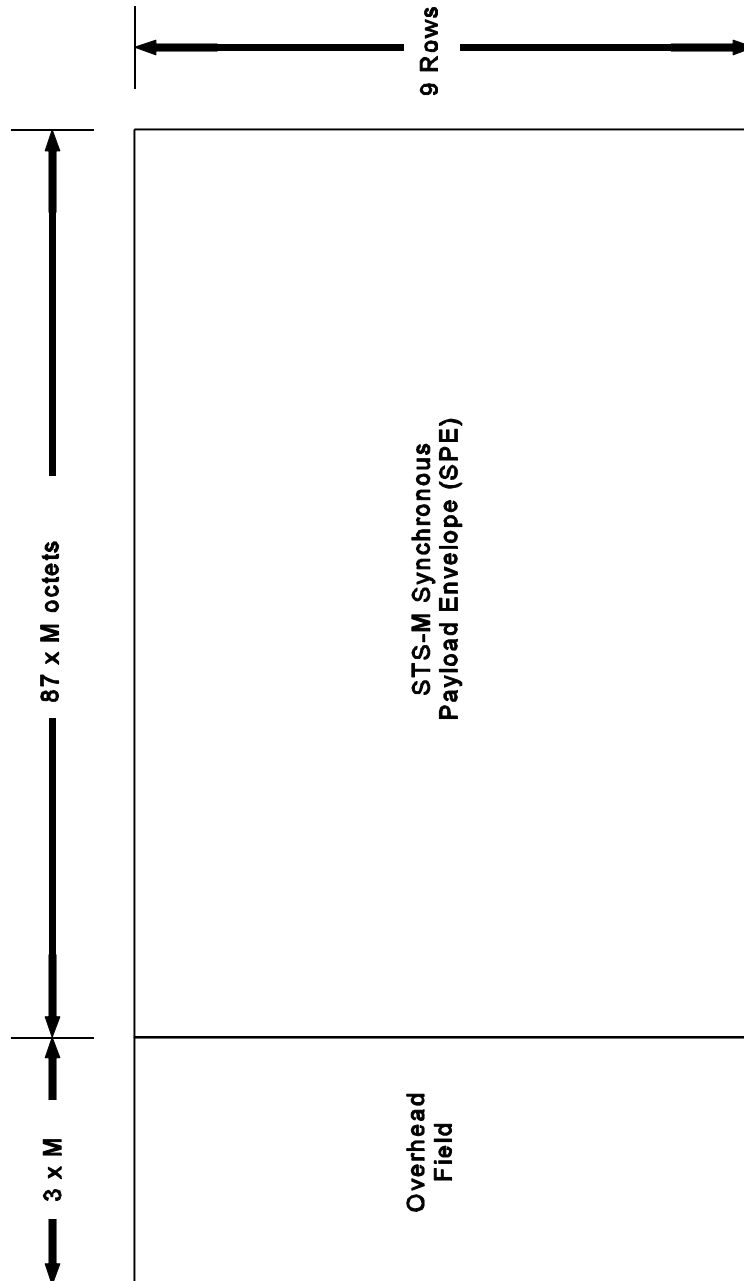
FIGURE 5.6. SONET STS-M frame format.

5.6.1.1.3 Services. The SONET standard is capable of supporting
a variety of connection-oriented and connectionless transport
data services. (The services that SONET supports include DS3
telecommunications signals, video, or low-rate telephone services
such as DS1, DS1C, or DS2 signals). The following SONET
concatenated rates shall be supported: STS-3C, STS-12C, and
STS-24C.

5.6.1.1.3.1 Management. The SONET standard incorporates
embedded operations channels within its overhead field. These
embedded operations channels shall be used to provide
communications capacity to support DIS integrated network
management. To facilitate the reliable transport of user
traffic, the overhead operations channel shall be multiplexed
into the STS-M frame to support link integrity.

5.6.1.1.4 Interworking support. SONET shall provide a layer 1
transport service for interworking between DIS network elements.

5.6.1.2 The Synchronous Digital Hierarchy

5.6.1.2.1 Rates. The SDH supports broadband services as a layer
1 capability. Table VIII shows the applicable SDH rates. The
basic SDH rate of 155.520 Mbps is designated STM-1. Other rates
are derived by multiplexing the basic rate in accordance with
CCITT Recommendations G.708 and G.709.

TABLE VIII. CCITT Recommendation G.707 rates
(Mbps).

STM-1	155.520
STM-4	622.080
STM-8	1244.160 (*)
STM-16	2488.320 (*)

NOTE:

(*) indicates rate under study by the CCITT.
STM-N = Synchronous Transport Module-Level N

In accordance with CCITT Recommendation G.709, provisions
shall be made to support sub-STM-1 rates.

5.6.1.2.2 <u>Frame format</u>. Figure 5.7 illustrates the STM-N frame format. For N=1, the STM-1 frame shall consist of 93 octets of overhead and 2337 octets of payload. An STM-N (where N>1) consists of 81 x N octets of overhead and 2349 x N octets of payload.

5.6.1.2.3 <u>Services</u>. The SDH shall support all services defined in 5.6.1.1.3.

5.6.1.2.4 <u>Management</u>. Network management services shall be supported via an embedded service channel within the SDH overhead structure. The SDH service channels shall support DIS network management objectives as specified in 5.7.

5.6.2 <u>Metropolitan area networks</u>. The DIS shall support the IEEE 802.6 DQDB. To support broadband services across large areas, multiple DQDB subnetworks may be interconnected to form MANs. MANs may be suitably interconnected to form wide area networks (WANs). By definition, MANs are subscriber-network elements within the DIS framework.

The primary objective of MANs shall be the establishment of a transparent and reliable (low delay and no loss of user throughput capacity) mechanism for interconnecting LANs. A transparent MAN environment is one in which two or more interconnected LANs appear as a single logical LAN to their respective users. The IEEE 802.6 standard has not been adopted as an international standard.

5.6.2.1 <u>Services</u>. The DQDB subnetwork is a distributed multi-access network that supports integrated communications services. Specifically, the DQDB supports connectionless data transfer, connection-oriented data transfer, and isochronous communications (e.g., voice). In support of connectionless services, annex B of IEEE 802.6 provides information on a mechanism for controlling bus communications between nodes. Currently DQDB/MAN related services are planned as a public offering within the contintental United States (CONUS). Outside CONUS, the DQDB/MAN architecture and its services must be supported as a private subscriber network element.

Connectionless packet service shall support variable-length packet service. The connection-oriented data service shall support a virtual channel between any pair of data service users. [A form of connection-oriented data service called Switched Multi-megabit Data Service (SMDS) shall be supported via the IEEE

802.6 compliant open bus when they are aligned at the connectionless MAC service via remote bridge.] The MAN reference model used to support these services is depicted in figure 5.8.
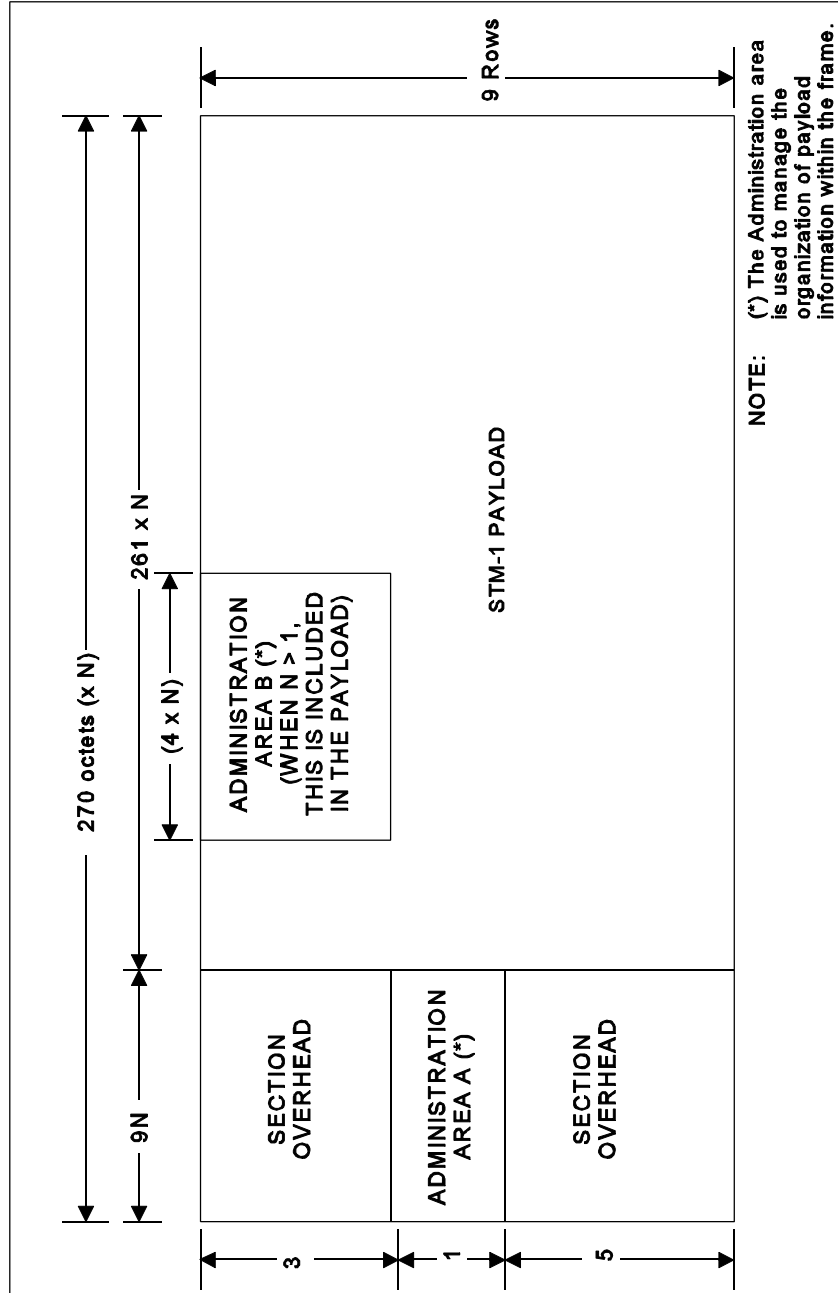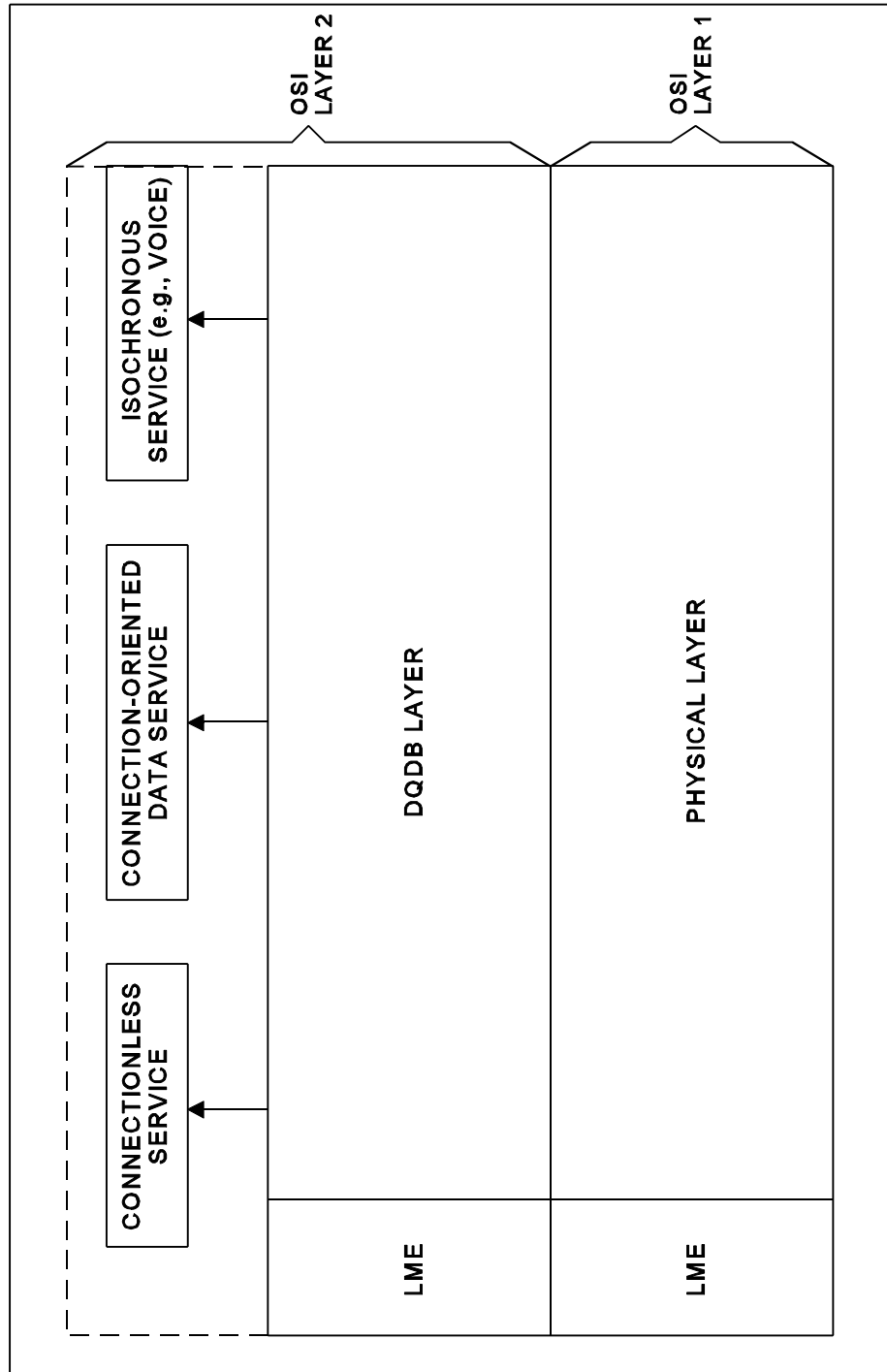
FIGURE 5.7. CCITT STM-N frame format.

FIGURE 5.8. IEEE 802.6 layer reference model.

5.6.2.2 <u>Rates</u>. The IEEE 802.6 DQDB/MAN standard supports high-speed transport of information across interconnected subnetworks within the DIS. Transport of information is achieved through the use of a 53-octet fixed-cell-based format. [The cell length is equivalent to that of an ATM cell. However, the ATM cell payload is between 44 and 48 octets, depending on whether the ATM Adaptation layer (AAL) uses a portion of the payload capacity for its purposes as defined in 5.6.3.] A DQDB/MAN located outside CONUS shall be interconnected via a SONET/CCITT Recommendation G.707 rate interface.

The rates supported are as defined in CCITT Recommendation G.703 (at 34.368 Mbps and 139.264 Mbps) and CCITT G.707 (at 155.520 Mbps). Lower-rate interfaces shall be supported via multiplexing in accordance with CCITT Recommendation G.709.

5.6.2.3 <u>Architecture</u>. Multiple DQDB subnetworks may be interconnected to form MANs via mediation devices (bridge, router, or gateway). MANs may be viewed as a public or private (e.g., DoD) backbone network. Figure 5.9 shows a notional interconnection of public and private MAN networks.

5.6.2.3.1 <u>DQDB subnetwork architecture</u>. A DQDB subnetwork uses a pair of unidirectional buses (a dual bus pair), referred to as Bus A and Bus B. Bus A and Bus B are independent from the point-of-view of data flow. That is, information on the buses flows independently in opposite directions.

A DQDB subnetwork shall support either an open dual bus or a looped dual bus; in the open dual bus topology, the head of Bus A (i.e., the information source node for Bus A) and the head of Bus B are logically separate and distinct. In the looped bus topology, the head of Bus A and Bus B are collocated.

Within the DQDB subnetwork, nodes shall be physically interconnected by a separate transmission link. A full-duplex transmission link shall carry both Bus A and Bus B management and user traffic between adjacent nodes. Eight levels of priority are supported by the DQDB standard. These levels of priority must be shared between network and user traffic.

5.6.2.4 <u>DQDB/MAN interworking</u>. In support of broadband interworking within the DIS, the IEEE 802.6 DQDB/MAN architecture and protocols shall be used to support any combination of LAN and ISDN connectivity (e.g., LAN-LAN, LAN-ISDN-LAN).

To simplify LAN/MAN interworking, the IEEE 802.6 MAN has been designed to be compatible with other LANs at OSI layer 2. Figure 5.9 depicts a typical scenario in which DQDB/MANs are
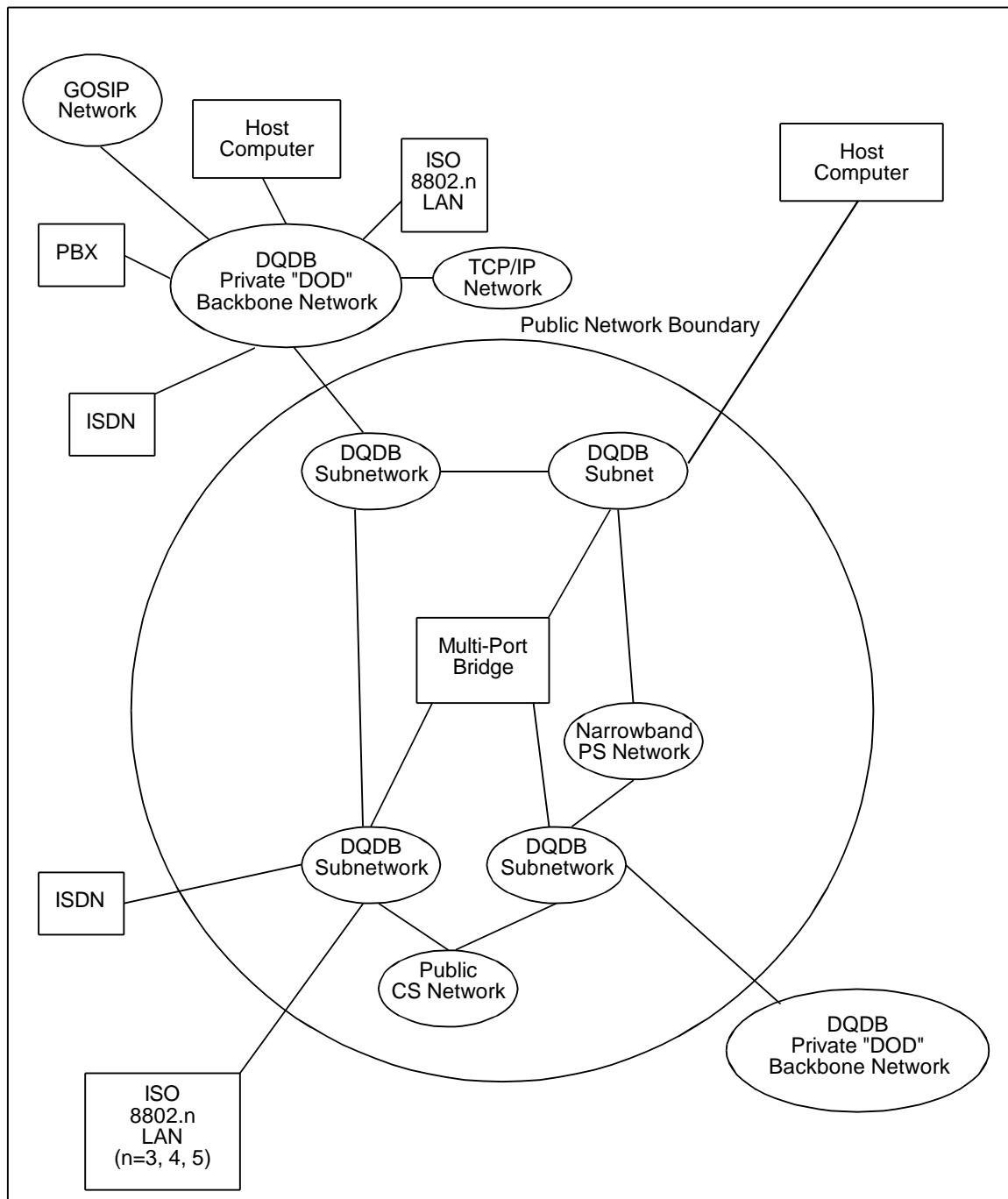
FIGURE 5.9. <u>Notional IEEE 802.6 interworking network architecture</u>.

interworking with a variety of other LANs, MANs, and end-systems (hosts and terminal equipments).

5.6.2.5 <u>Protocol</u>. The DQDB shall employ management, signaling, and traffic protocols to control and monitor access and use of its resources.

5.6.2.5.1 <u>Signaling</u>. Signaling associated with IEEE 802.6 services is not specified within the standard. Wherever possible, existing signaling protocols (e.g., CCITT Q.931) shall be employed. The signaling shall provide for interworking across public networks that use SS7.

5.6.2.5.2 <u>Management</u>. To support integrated DIS network management, the DQDB/MAN shall provide for local and remote management and control of its resources.

5.6.2.5.2.1 <u>Local node management</u>. Local management is not subject to the OSI management definition since all information flow is local to the node's management process. However, when MANs are interconnected via a DIS local- or wide-area network element, the local management shall conform to the management concept defined in 5.7.

5.6.2.5.2.2 <u>Remote management via network/system management</u>. A node's physical and data-link layer objects are monitored, controlled, and coordinated via DIS network management through the DQDB layer management interface. System management application functions shall provide for monitoring, control, and coordination of managed objects through interaction with the DQDB layer management interface.

5.6.2.5.2.3 <u>Remote management via DQDB layer management</u>. Remote management shall provide for remote monitoring, control, and coordination of managed objects within a local node.

5.6.3 <u>The asynchronous transfer mode</u>. The ATM shall be used to provide broadband services. The ATM shall be a transport connection-oriented packet service. The ATM shall provide trunking between the DIS local-network element and the wide-network element at DIS reference point B. The ATM shall comply with draft CCITT Recommendations I.150 and I.361 after approval.

5.6.3.1 <u>The ATM services</u>. The ATM shall support two primary services: interactive and distribution. Interactive services shall correspond to conversational, messaging, and retrieval

service. Distribution services shall provide for user
control/noncontrol of presentation services. Service parameters
shall be negotiable on a cell-by-cell basis, subject to network
management constraints and limitations on parameter ranges. The
ATM shall support CONS and CLNS.

5.6.3.1.1 <u>Multimedia service support</u>. Independent network
access and connection control functions shall not restrict
concurrent support of mixed services (e.g., audio and video) on a
single connection. Further, there shall be no inherent
impediments to the establishment of multiple connections
associating a specific information type. Addition and deletion
of optional information types (such as voice, data, facsimile,
video) during an active network access shall not be inhibited.

5.6.3.2 <u>The ATM cell attributes</u>. The ATM cell format and cell
transfer rate shall comply with 5.6.3.2.1 and 5.6.3.2.2.

5.6.3.2.1 <u>Cell format</u>. The ATM shall be based on the cell
structure shown in figure 5-10. The multiplexed information
shall be organized as fixed-sized frames called cells. The ATM
cell structure shall provide the transport mechanism for
information delivered to the User Network Interface (UNI). The
UNI shall logically correspond to the DIS at reference point B.
The ATM cell presented to the UNI shall be identical to the cell
at the network-node interface (NNI), except the NNI cell shall
not provide for cell flow control. The UNI shall not flow
control incoming network cells.

     The ATM cell structure shall be functionally divided into
three fields: the cell header field, the AAL field, and the user
information part. The AAL field shall correspond to the first
four octets of the user information part (information payload) of
a cell.

5.6.3.2.2 <u>Cell transfer rate</u>. The ATM supports constant bit
rate (CBR) and variable bit rate (VBR) end-to-end bearer service
connections. ATM UNI operational rates shall be 155.52 Mbps
(SONET STS-3 and CCITT STM-1) and 622.08 Mbps (SONET STS-12 and
CCITT STM-4). The ATM shall not inhibit operation across lower-
rate digital hierarchies.

5.6.3.3 <u>The ATM reference model</u>. Figure 5-11 depicts the ATM
layered protocol reference model. The layered ATM reference model
(ATM-RM) shall be functionally aligned with the ISO OSI RM. The
ATM-RM shall consists of a physical layer 1, a data link layer 2

(to include the ATM sublayer and AAL functionality) (see
5.6.3.3.2.), and higher layers corresponding to the ISO OSI RM
layers 3 through 7. The ATM reference model shall comply with
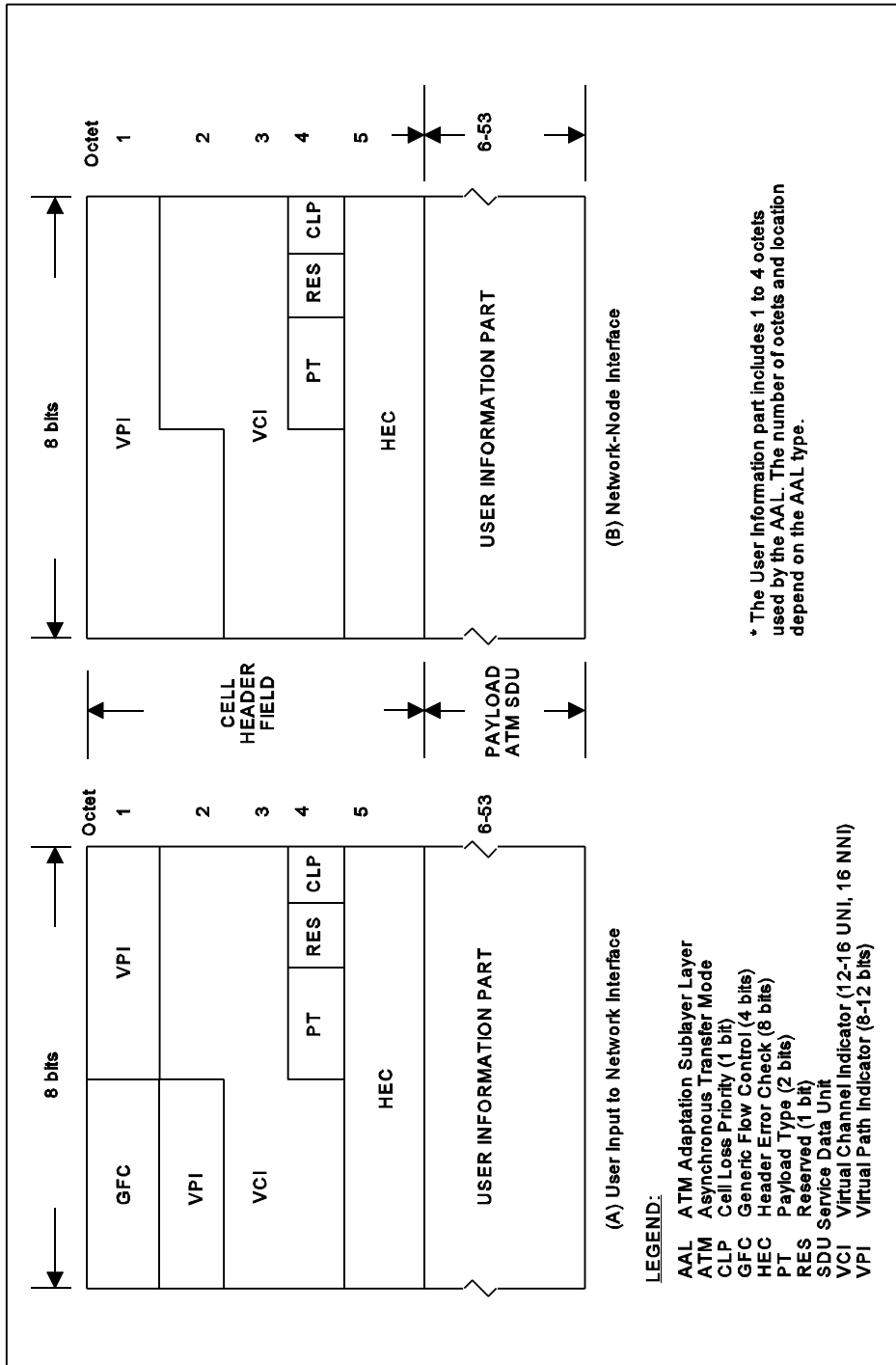draft CCITT Recommendations I.321 and I.327, after approval.

FIGURE 5-10. ATM cell structure.

LEGEND:
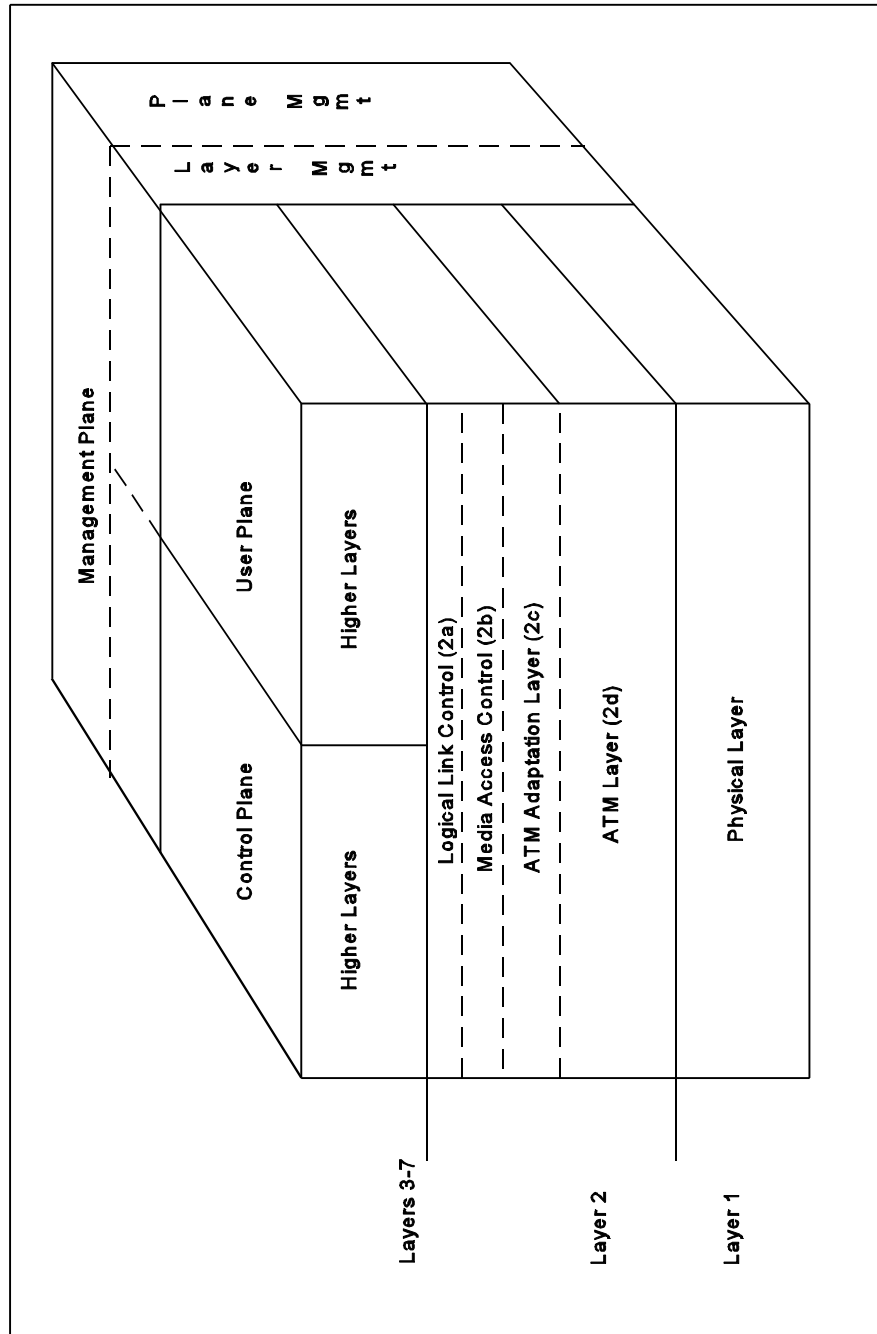
AAL   ATM Adaptation Sublayer Layer
ATM   Asynchronous Transfer Mode
CLP   Cell Loss Priority (1 bit)
GFC   Generic Flow Control (4 bits)
HEC   Header Error Check (8 bits)
PT   Payload Type (2 bits)
RES   Reserved (1 bit)
SDU   Service Data Unit
VCI   Virtual Channel Indicator (12-16 UNI, 16 NNI)
VPI   Virtual Path Indicator (8-12 bits)

* The User Information part includes 1 to 4 octets used by the AAL. The number of octets and location depend on the AAL type.

(A) User Input to Network Interface

(B) Network-Node Interface

FIGURE 5-11. The ATM protocol reference model.

5.6.3.3.1 <u>Preferred ATM physical layer (layer 1)</u>. The preferred
ATM physical layer shall be based on the ANSI TI.105-1988 SONET.
The ATM sublayer shall be functionally independent of the layer 1
digital hierarchy. The ATM shall support asymmetric interface
connections. Asymmetric interfaces shall be those interfaces in
which the transmission rate across the interface is not the same
in both directions. The ATM physical layer shall comply with
draft CCITT Recommendation I.432, and ISO DIS 9314-3, after
approval.

5.6.3.3.2 <u>The data link layer (layer 2)</u>. The ATM protocol shall
reside at the data link layer. The data link layer in support of
the ATM shall be functionally separated into an AAL and an ATM
layer. The AAL shall perform functions required by the
Application profiles, and control and management planes. In
addition, it shall support the mapping between the ATM sublayer
and the OSI RM layer 3 function. The AAL shall comply with draft
CCITT Recommendation I.363 after approval. The ATM sublayer
shall ensure delivery of cells.

The AAL shall provide CBR and VBR service support to ISO
layers 3 to 7 through the definition of four types of AAL service
functions. The AAL type 1 functions shall support CBR service.
The AAL type 2 functions shall support CBR service. The AAL type
2 functions shall support VBR service. The AAL type 3 functions
shall provide message and streaming services. The Type 3
function shall transport end-to-end one or more (optional) AAL
convergence sublayer protocol data units (PDU) in the message
mode. Streaming mode service shall provide end-to-end transport
of one or more fixed-size service data units (SDUs) within a
single AAL convergence sublayer PDU. Delivery of AAL PDU(s) may
be tagged as guaranteed or not-guaranteed. The AAL type 4
functions shall provide connection-oriented and connectionless
point-to-multipoint VBR message and streaming mode service
through the ATM network. The message and streaming mode services
shall be functionally identical to the AAL type 3 function.

The ATM sublayer shall provide a common transfer capability
to all services, including connectionless services. The ATM
sublayer shall support user end-system control of traffic from
multiple CBR regular and VBR ATM connections that have various
QOS classmarks.

5.6.3.4 <u>ATM interworking</u>. The ATM connections shall support
basic ISDN user and signaling services. The ATM shall not
inhibit interworking between itself and the basic (nB+D) ISDN

network. Interworking with non-ISDN networks shall be
accomplished via a network adapter. The network adapter shall
provide the necessary translation functions required to ensure
that ATM cell information content is delivered to its
destination. The adaptor shall be implemented within the ATM
terminal equipment or via an external ATM terminal adapter. The
AAL shall support connections between ATM and non-ATM interfaces.

5.6.3.4.1 <u>ATM cell interworking</u>. When interworking between ATM
and non-ATM networks within the DIS is required, cell translation
shall be performed at the UNI. Cell translation applies to a
manipulation of the ATM cell header information to support the
routing required by the non-ATM network. No additional
information shall be required of the ATM cell to support the
interworking function.

5.6.3.5 <u>ATM signaling</u>. (It is envisioned that SS7 will
eventually support the ATM). The ATM shall provide a flexible
transport service common to connection and connectionless network
and bearer services. The preferred method of signaling shall be
through the use of separate channel identifiers. Out-of-band
(and for interworking in-band) signaling shall be supported. ATM
signaling shall comply with draft CCITT Recommendation I.311,
after approval.

     The ATM signaling function shall support control of ATM
virtual channel connections (VCCs) and virtual path connections
(VPCs) for information transfer. The signaling function shall
support simple multipoint and multiconnection network accesses.

     The ATM shall allow for multiple types of services and for
the logical separation of signaling from the user information
stream. The ATM signaling mechanism shall not prevent a user
from supporting multiple signaling entities connected to the
network call-control management function via separate ATM VCCs.

5.6.3.5.1 <u>Signaling configurations</u>. The ATM shall support three
signaling configurations designated Case A, Case B, and Case C.
The Case A configuration shall provide for the establishment of
virtual channel (i.e., connectionless) connections through the
DIS. Case B shall provide for the establishment of virtual paths
(i.e., connection-oriented) connections through the DIS. Case C
shall provide for both connectionless and connection-oriented
connections through the DIS.

5.6.3.5.2 <u>ATM connectionless service support</u>. The ATM shall support B-ISDN connectionless data service between functional groups able to handle connectionless messages. The ATM shall provide direct and indirect support of connectionless services. The ATM connectionless service support shall comply with draft CCITT Recommendation I.327, Annex A, after approval.

5.6.3.5.2.1 <u>ATM direct support of CLNS</u>. In order to access connectionless data services, a connection shall be established between the local network element and the ATM network's connectionless service function (CLSF). The CLSF shall reside within the DIS local and wide area networks. The CLSF shall terminate connectionless protocols and reroute cells to the destination end user, based on cell routing information. Direct support of connectionless service is defined to be Case A. The ATM direct support of CLNS shall comply with draft CCITT Recommendation I.211, after approval.

5.6.3.5.2.2 <u>ATM indirect support of CLNS</u>. The connectionless protocol shall be invisible to and independent of the ATM switching function located within the local and wide area networks. ATM indirect support of connectionless services shall be via the connection-oriented service. A transparent connection of the ATM layer, either permanent, reserved, or on-demand, shall be used between B-ISDN. To ensure that no impediments exist to the adoption of a CL protocol, the CL and AAL functions shall be implemented outside ISDN. ATM Case A shall provide indirect support of connectionless services. The ATM indirect support of CLNS shall comply with draft CCITT Recommendation I.211, after approval.

5.6.4 <u>Frame relay mode</u>. The DIS shall support the frame relay mode (FRM). Support of FRM within the DIS shall conform to the ISDN FRM bearer service definition and architectural framework defined in ANSI T1.606. The ANSI FRM definition is closely aligned with CCITT Recommendation Q.922.

5.6.4.1 <u>Services</u>. Although the ANSI FRM is, by definition, an ISDN packet mode bearer service, the FRM service definition does not inhibit its use with any suitable low-bit-error-rate service.

The FRM shall be capable of supporting a variety of connection-oriented and connectionless transport data services. These services shall support the following DIS service access definitions:

a.   Circuit-switched access to the DIS network element's remote frame handler (FRM-Case A). The B- and H-channels shall be used to support this access method.

b.   Virtual access via the DIS network element's local ISDN connection (FRM-Case B). The B-, H-, and D-channels shall be used to support this access method.

It shall be possible to establish access connections on a demand and permanent basis in accordance with ANSI T1.617. Multiplexing of multiple subscriber data streams onto a single connection, unlike CCITT X.25, shall be performed at the link layer.

5.6.4.2 <u>Rates</u>. The FRM shall have the capability of using the strategic-local network B-, H-, and D-channels and tactical-local network bit rates from 16 kbps to 2.048 Mbps. When using the basic rate ISDN interface, the FRM shall operate at the 64-kbps rate. The FRM use of the D-channel shall be at either the basic (16-kbps) or the primary (64-kbps) rates. The D-channel rates are only applicable for the FRM-Case B.

5.6.4.3 <u>Format</u>. The FRM frame format shall be as depicted in figure 5.12 and defined in ANSI T1.618. The fields identified in the figure are described as follows:

Flag: Each frame contains a beginning and closing HDLC flag. The flags are used to indicate the beginning and end of a negotiated packet of user information.

Address: The address field is used to support routing and network status (e.g., congestion) control information.

Control: The FRM does not employ the HDLC control field.

Information: The information field shall support the transport of a defined amount of user information. The default information field size is 262 octets (chosen to be compatible with LAPD on the D-channel). The minimum frame relay information field size is one octet. The support by networks of a negotiated maximum value of at least 1600

octets is recommended for applications such
as LAN interconnect, to minimize the need for
segmentation and reassembly by the user
equipment.

Frame check   The frame check sequence (FCS) is used to
sequence: provide error-checking. The FCS is defined
                   to be a 16-bit sequence.

5.6.4.4 <u>Management</u>. The FRM provides no intrinsic network
management capability. Thus, the FRM shall be managed as a layer
1 and layer 2 service in accordance with relevant portions of
5.7.

5.6.4.5 <u>Interworking</u>. The FRM shall support interworking
between tactical-local network and strategic-local networks.
Interworking via the FRM shall support LAN-to-LAN, and terminal-
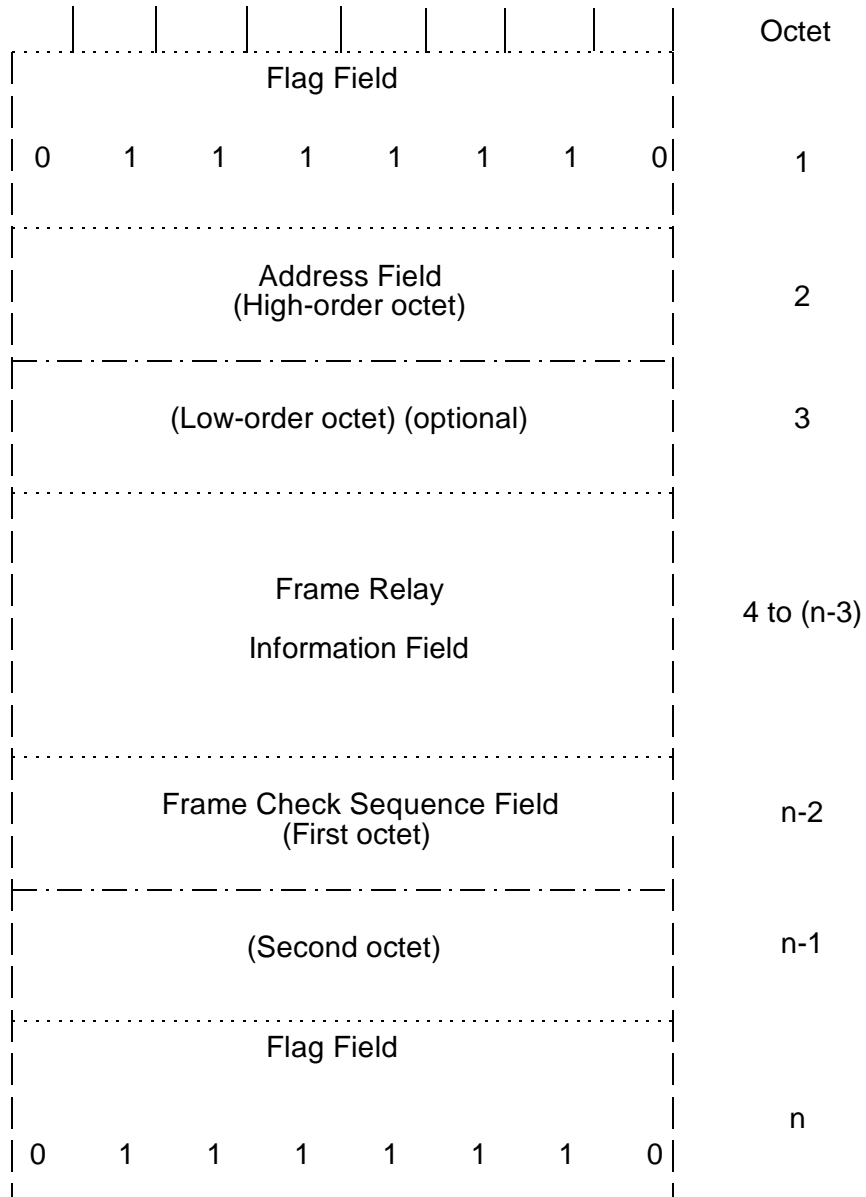to-terminal interconnections. (Where feasible, the FRM may also

	Octet
Flag Field 0 1 1 1 1 1 1 0	1
Address Field (High-order octet)	2
(Low-order octet) (optional)	3
Frame Relay Information Field	4 to (n-3)
Frame Check Sequence Field (First octet)	n-2
(Second octet)	n-1
Flag Field 0 1 1 1 1 1 1 0	n

FIGURE 5.12. Frame format for frame relay mode.

take advantage of broadband transport services to traverse non-FRM network segments.)

5.7 <u>Network management</u>. To maintain a coherent and stable network, each segment of the DIS shall support a local network management function as indicated in figure 5.13. The Telecommunications Management Network (TMN) architecture, as defined in CCITT M.30, shall be used as the basis for a common network management framework within the DIS. The TMN shall provide a framework for management of both signaling and user network resources. The TMN framework shall support management information exchanges between peer and subordinate network management entities. Within individual TMN elements (e.g., NEs), the OSI system management framework shall be used. Part 18 of NIST Special Publication 500-183 provides stable implementation agreement to enable independent vendors to supply customers with a diverse set of networking products that can be managed as part of an integrated environment.

5.7.1 <u>Network management objective</u>. Network management entities (DIS systems supporting network management) shall make maximum use of integrated and automatic management aids to facilitate effective and responsive support of the Specific Management Applications Functions (SMAFs). Network management as defined in this standard does not attempt to establish bounds on or restrict implementation of any aspect of DIS network management, but rather to define its minimum required degree of interoperability. When applicable, MIL-STD-2045-38000 shall define the DIS network management within a DoD facility.

5.7.2 <u>Network management infrastructure</u>. The network management infrastructure shall consist of the network management architecture, network administration, and management communications.

5.7.2.1 <u>Architecture</u>. The TMN shall support the establishment of a common and coherent framework for network management. Network management as exercised via the TMN architecture shall not inhibit the establishment of a centralized, distributed-hierarchical or distributed-peer management (sub)architecture or any combination thereof within a DIS element. To support either a centralized or distributed DIS management objective, a virtual network management strategy shall be adopted. Virtual network management shall imply the use of a common framework (architecture and services) for the management of all resources within all elements of the DIS. The virtual network management approach shall in no way restrict achievement of the overall DIS network management objective stated in 5.7.1. The DIS TMN architecture shall support network management within a DoD

facility as defined in MIL-STD-2045-38000 and shown in figure 5.14.
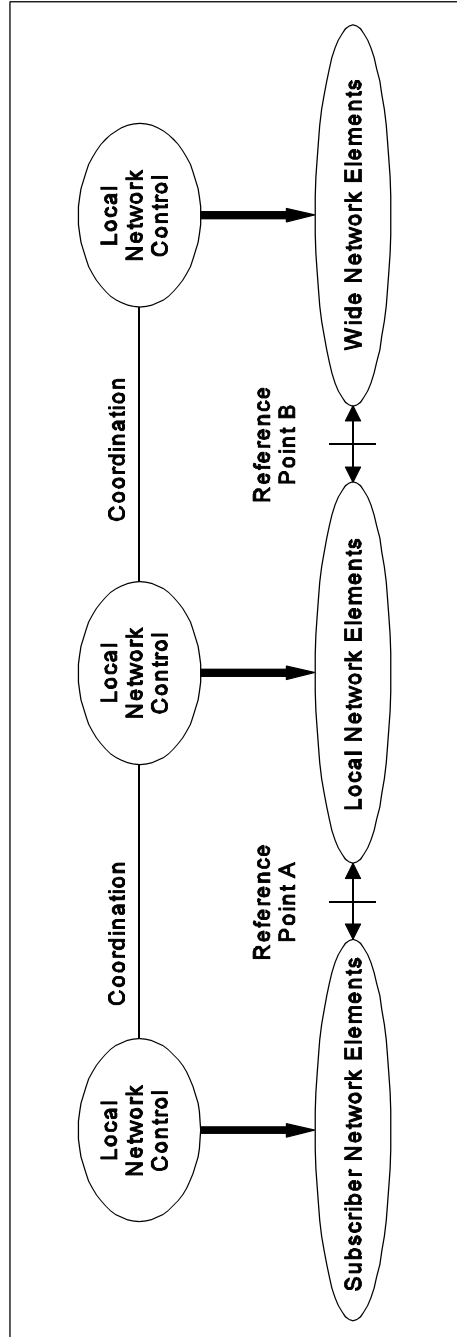
FIGURE 5.13. Overview of the DIS network management scenario.

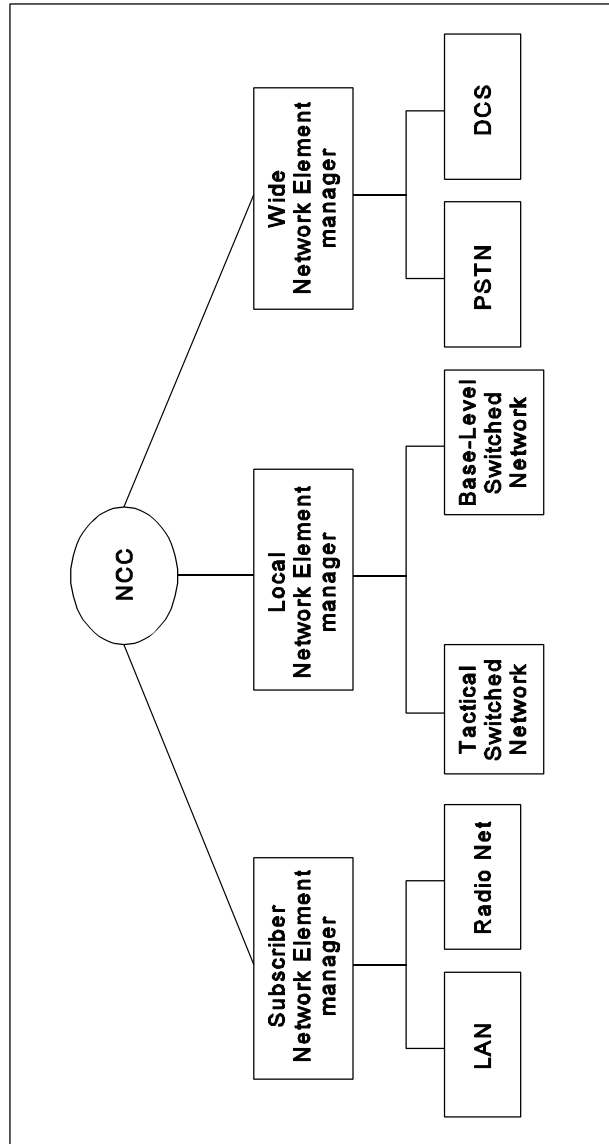FIGURE 5.14. Typical intrabase distributed-hierarchial network management architecture.

TMNs shall support internetworking across the DIS to provide end-to-end network (and path) management. A TMN associated with a specific DIS element may employ a subset of the typical TMN architecture. (That is, differences may exist between TMN network topologies. This difference may translate into a variance in the type and number of equipment used in TMN. Employment of a TMN subarchitecture shall not imply a reduction in the degree of management functional control.)

A TMN shall have an Operating System (OS) function to exercise control of manageable resources within its domain. A TMN's domain may extend across an entire DIS network or some portion thereof. The OS shall also support an external management interface for authorized remote access and control. The OS shall interface to the backbone (or subnetwork) Data Communications Network (DCN) for the exchange of management information between other peer or subordinate TMNs. A workstation function shall provide a local administration interface to the TMN. A notional TMN is shown in figure 5.15. Local management within TMN elements shall be in accordance with MIL-STD-2045-38000.

5.7.2.2 <u>Administration</u>. The administration architecture (i.e., operational control) within the DIS, in accordance with DoD policy, shall conform to the distributed-hierarchical management structure. Subadministrations shall be designated by the DIS administrator to support network operations at lower echelons. All primary network element (NE) nodes (e.g., switch) designated by the DIS administrator shall have a network administration function. The subadministrator shall be responsible for executing network management functions within a management domain. All administrators shall perform their management functions through the employment of the common network management infrastructure and a set of uniform management services.

5.7.2.3 <u>Communications</u>. Although the TMN is logically a separate network from the user and signaling traffic networks, which its manages, it shall be capable of using these networks to support its communications requirements. Provisions shall be made to support management communications between two or more principal (sub)networks of a DIS element. A principal (sub)network shall contain a network management entity. A point-to-point circuit shall be available to link a DIS segment consisting of two (sub)networks. An omnibus circuit shall be available to link tandem (sub)networks. The management circuits

shall provide an ability for network administration and/or manager processes to exchange management information in accordance with ISO DIS 9595 and ISO DIS 9596.
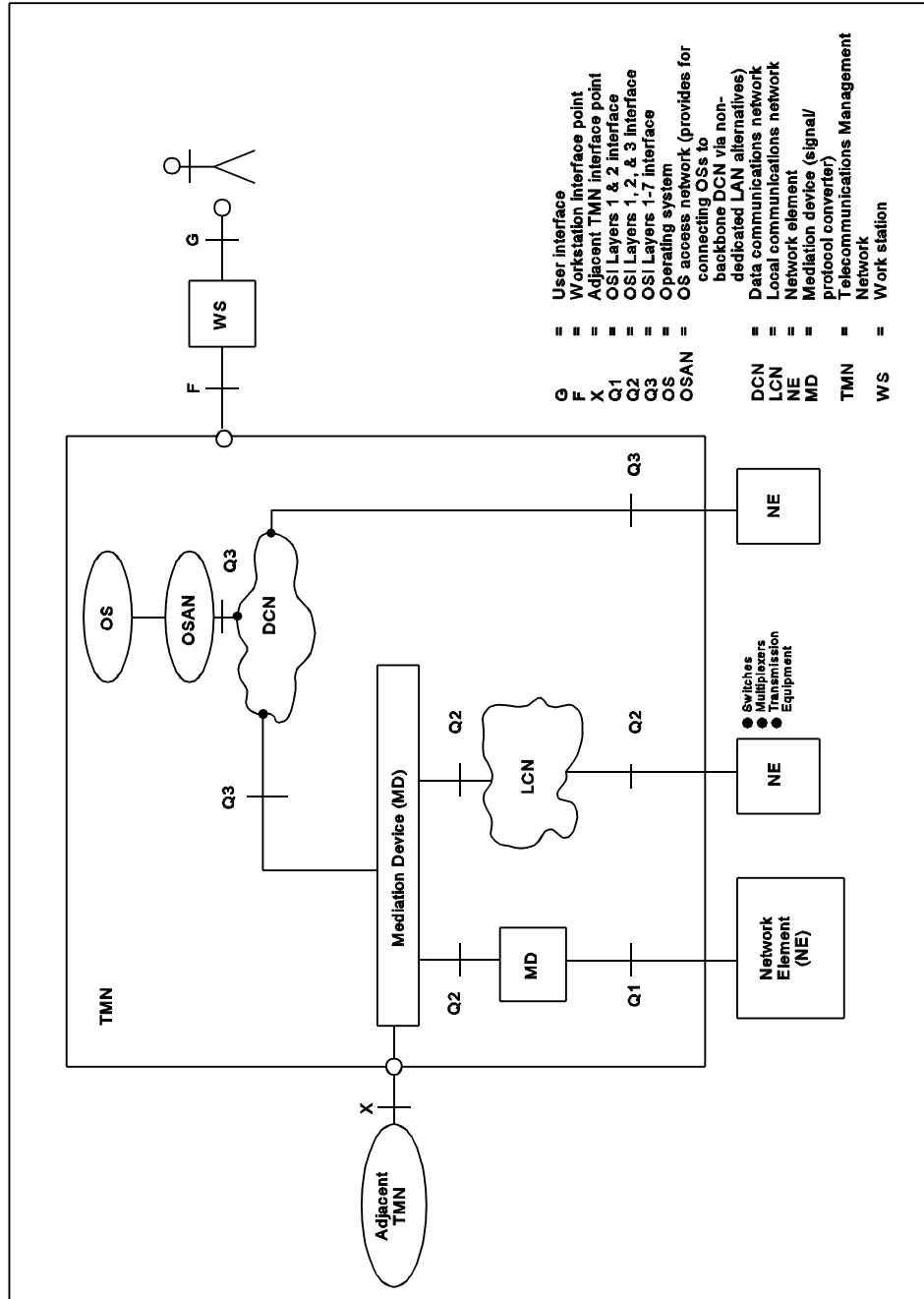
FIGURE 5-15. Notional TMN architecture.

G = User interface
F = Workstation interface point
X = Adjacent TMN interface point
Q1 = OSI Layers 1 & 2 interface
Q2 = OSI Layers 1, 2, & 3 interface
Q3 = OSI Layers 1-7 interface
OS = Operating system
OSAN = OS access network (provides for connecting OSs to backbone DCN via non-dedicated LAN alternatives)

DCN = Data communications network
LCN = Local communications network
NE = Network element
MD = Mediation device (signal/protocol converter)

TMN = Telecommunications Management Network
WS = Work station

5.7.3 <u>Network management requirements</u>. The following network management requirements as defined in ISO DIS 10165-2 shall support the establishment, (re)configuration, and maintenance of a stable signaling and user network environment. The network management entities shall be supported by SMAFs, which are defined in 5.7.3.1 through 5.7.3.5.

5.7.3.1 <u>Fault management</u>. Fault management, in accordance with CCITT M.20, M.30, and M.36, shall allow for detection, isolation, and correction of abnormal (i.e., unplanned) operation of the telecommunications network. A TMN elements maintenance service provider (MSP) shall not disturb any other domain when attempting to localize a fault. To accomplish the fault management objective, the following functions shall be supported:

    a.   Alarm surveillance

- A TMN shall provide the capability to monitor NE failures in near-real-time.

- Spontaneous error reporting.

- Error threshold alarm reporting.

- Continuous monitoring.

    b.   Fault localization

- Trouble isolation.

- Fault tracing.

- Supplementary fault isolation shall be provided when initial failure information is insufficient for fault localization. Internal and/or external test assets shall be controllable by a TMN. Remote control via local management process shall be sufficient.

    c.   Testing (requested, on-demand, routine scheduled)

- Diagnostic testing.

- Confidence testing.

    d.   Resource management

- Maintenance functions (corrects isolated faults and maintains operating conditions)

- Resource (re)initialization

- Resource identification.

An appropriate set of fault management procedures and objects shall be defined to enable effective and responsive fault management. Where necessary, the fault management function shall interact with other SMAFs to accomplish its management function.

5.7.3.2 <u>Configuration management</u>. Configuration management shall support functions necessary for exercising control over, identifying, collecting data from, and providing data to NEs. To accomplish these objectives, configuration management shall provide the following:

    a.   Provisioning function:

- The provisioning function shall provide for the ability to control/activate equipment into service (not including installation). The TMN administration shall initiate the service status of equipment (in service, out-of-service, stand-by, reserved) and selected parameters.

    b.   Status and control functions:

- The TMN administration shall have the ability to monitor and control certain NE attributes on demand (i.e., checking/changing service state; initiating/terminating diagnostics; and rearranging equipment or rerouting traffic in response to faulty NE equipment). Ability to assess impact of a potential NE's configuration prior to activating that configuration.

    c.   Installation function:

- The TMN shall support installation of equipment and/or channels into an active network.

An appropriate set of configuration management procedures and objects shall be defined to enable effective and responsive configuration management. Where necessary, the configuration management function shall interact with other SMAFs to accomplish its management function.

5.7.3.3 <u>Performance management</u>. To execute performance management as defined in CCITT M.20 and M.30, functions shall be provided to evaluate and report on the behavior of network elements and their effectiveness in meeting desired performance objectives. Performance management shall pertain to the following functions:

    a.   Performance Monitoring:

- Collecting and reporting of traffic data trends in traffic load, bandwidth utilization, and response time.

- Reporting end-to-end circuit trends

- Detection of:

    --   Loss of frame sync

    --   Loss of signal

    --   Alarm indication signal

    --   Alarm information to the remote end

    --   Slips

    --   Restoration indication signal

- Bit error indicators:

    --   Code violations

    --   FCRC errors

    --   Frame alignment signal errors

    --   Block parity errors

    --   Errored seconds

-- Severely errored seconds

-- Degraded minutes

● Loss of signal energy

● Applying controls:

-- Congestion

-- Exceeding Allocation

b.   Traffic management functions:

●   A TMN collects traffic statistics data from NEs to reconfigure the telecommunications network or modify operations in response to extraordinary traffic conditions.

●   The TMN receives traffic reports (periodically, on demand, or as a result of the NEs exceeding its threshold). The TMN may reset an NE's threshold for generating reports.

●   Raw data or summary reports shall be available from an NE upon the TMN administrator's request.

c.   Quality-of-service:

●   (Same basic items identified for traffic management above.)

●   The QOS function shall monitor and record the following parameters:

--   Connection establishment (e.g., call setup delays, successful and failed call requests).

--   Connection retention.

--   Connection quality.

---   Historical system state

---   Cooperation with fault (or maintenance) management to establish cause of possible failure of resources

---   Cooperation with configuration management to adopt routing and load control parameters and limits

---   Initiation of test calls to monitor QOS parameters.

An appropriate set of performance management procedures and objects shall be defined to enable effective and responsive performance management. Where necessary, the performance

management function shall interact with other SMAFs to accomplish
its management function.

5.7.3.4 <u>Security management</u>. Security management shall pertain
to the monitoring and control of access to network resources and
services. To meet this objective, the following shall apply:

    a.   Peer entity authentication exchange

    b.   Access control

    c.   Connection confidentiality

    d.   Connectionless confidentiality

    e.   Selective field confidentiality

    f.   Traffic flow confidentiality:

- Signaling message protection

- Traffic padding

- Stable routing tables

    g.   Connection integrity (with or without recovery)

    h.   Selective field connection integrity

    i.   Connectionless integrity

    j.   Selective field connectionless integrity

    k.   Nonrepudiation (origin or delivery):

- Digital signature

- Data origin authentication

- Notorization

    l.   Data integrity

An appropriate set of security management procedures and objects
shall be defined to enable effective and responsive security

management. Where necessary, the security management function shall interact with other SMAFs to accomplish its management function.

5.7.3.5 <u>Account management</u>. Account management shall pertain to resource utilization and audit tracing. The network management process shall be capable of performing all functions necessary to meet these account management objectives. To meet the objective, the management process shall provide as a minimum the following:

    a.   Traffic summary

    b.   Resource utilization statistics

    c.   Circuit status

    d.   Billing

An appropriate set of account management procedures and objects shall be defined to enable effective and responsive account management. Where necessary, the account management function shall interact with other SMAFs to accomplish its management function.

5.7.4 <u>Managed objects</u>. All system management entities within a DIS network element's TMN domain shall maintain a set of manageable objects. An object is an abstract means of referencing controllable (manual or automatic) physical and logical equipment and their related signaling, management, and user services within the DIS. Resources within a management domain having control, status, and test points and services shall organize their subordinate objects in a containment hierarchy. The object's containment hierarchy shall define the internal relationship of objects within the management information base (MIB). Managed objects shall have a defined association within and between SMAFs (see 5.7.3).

5.7.4.1 <u>Management information base</u>. The MIB shall contain common standard definitions of all manageable objects within a control domain. Where appropriate, the MIB shall contain locally and globally (intermediate gateways and other DIS elements) significant object definitions. Provisions shall be made to allow specific DIS element specific extensions to the common MIB.

5.7.4.2 <u>Object definition</u>. All objects defined within the MIB shall be defined using the techniques and templates specified in

the FIPS XXX, the section titled *Guidelines for the Definition of Management Objectives* and further constrained by NIST Special Publication 500-183 (Part 18, clause 7). All managed objects must have registered object identifiers. In accordance with ISO DIS 10165-1/2/4, the structural definition of an object shall include:

    a.   Object Name Identifier (in terms of the ASN.1 notional language)

    b.   Syntax (i.e., type of object: numeric, global, threshold)

    c.   Access (i.e., read-only, read-write, write-only, not accessible)

    d.   Status (i.e., mandatory, optional, obsolete)

    e.   Description (textual description of the object)

    f.   State (service availability to which object refers)

    g.   Schedule (time-driven actions)

    A DIS element may also require locally unique intraelement objects. These objects shall be defined in a partitioned extension of the MIB. Due to the potential, unique characteristics of a particular DIS element, the defined set of objects associated with a DIS element shall be called "native" elements.

5.7.4.3 <u>Interworking objects</u>. The DIS stipulates that interworking is a requirement. Thus, where necessary, a set of objects shall be defined for the management and control of internetworking across heterogeneous DIS elements. A class of manageable objects shall be reserved for coordinating between TMNs. Internetworking shall have minimal impact on signaling traffic, user traffic, and their services.

5.7.5 <u>Security considerations</u>. Network management via security features associated with the SMAFs shall provide the necessary level of security for all DIS network management objects.

5.7.5.1 <u>SMAF execution</u>. Strict security provisions shall be defined and designed into the network infrastructure at the administrator, manager, agent, and object levels to control

unauthorized access to and operation of SMAFs associated with each DIS TMN. Security consideration of the user information flow shall be taken into consideration when gaining or allowing access to manageable user traffic objects.

5.7.5.2 <u>Access to managed objects</u>. The network management function shall gain access to a managed object via its management protocol. The management protocol shall interrogate the object's agent to provide physical access to the object. Examination of an object shall be consistent with the level of control and security possessed by the requesting administration's management function. Where authorization exists, the object's descriptive attributes may be modified by the network management function. Attempts to access to undefined objects shall not create an unpredictable response from a network agent.

5.8 <u>Performance standards</u>. Terminal-to-terminal performance standards, applied to hypothetical reference circuits (HRC), are included in this standard to provide system designers and planners with a consistent basis for establishing system parameters.

5.8.1 <u>Hypothetical reference circuits</u>. An HRC has a specified configuration and length. It is based on such factors as communications requirements, user satisfaction, equipment performance, installation and operation procedures, and experience. Reference circuit configurations, such as the number of links, trunks, and nodes in tandem with associated transmission equipment, are chosen so that each configuration can be considered representative of a typical network or subsystem operational circuit. The nominal length of a reference circuit normally represents the probable maximum distance over which communications are required in the network or subsystem under consideration.

An HRC is used (a) as a reference for the performance of planned or operational circuits; (b) as guidance for planning and engineering circuits and networks; (c) as a means of prorating and allocating transmission parameters to different portions of a circuit and associated equipment; and (d) as a basis to derive interface, subsystem, and equipment standards.

Normally, in an operational communications system, various circuits with different lengths and parameters from the HRCs must be employed. It is not practical to standardize the performance of every link or circuit that may have to be engineered and

installed. The purpose of standardizing performance on an end-to-end basis (and defining HRCs) is to ensure that actual links, trunks, and circuits will perform satisfactorily as parts of an overall subsystem or system.

Designers and circuit engineers are expected to make their own assumptions and decide on such factors as length of radio links; channel perturbations, such as noise and jitter; number of PCM, ADPCM, and CVSD tandem links; number of A/D conversions; and delay characteristics to optimize circuit performance.

5.8.2 <u>Hypothetical reference connections</u>. The HRCs described in 5.8.2.1 and 5.8.2.2 can also be viewed as hypothetical reference connections (HRX) for circuit-switched calls or packet-switched calls. End-to-end performance parameters given in 5.8.2.2 and 5.8.3 apply only to circuit-switched calls. End-to-end performance parameters for packet-switched calls are a subject for further study.

5.8.2.1 <u>Wide-network segments</u>. The segments that constitute each HRC are summarized in table IX.

TABLE IX. <u>Reference segments for wide-network segments</u>.

REFERENCE SEGMENT	DESCRIPTION
Tail	Same as 320-km terrestrial segment.
320-km terrestrial segment	Eight line-of-sight (LOS) radio repeater links.
Satellite or transoceanic submarine cable	One satellite link with a 40-km LOS radio link at one end, and a metallic or fiber optic cable connection at the other end.

5.8.2.2 <u>Error-free-second ratio allocation</u>. The error-free-second (EFS) ratio allocation for each segment and the resulting performance for each HRC is provided in table X.

5.8.3 <u>Wide networks</u>. Three HRCs for wide networks exist. They are illustrated in figure 5.16. The parameter selected to characterize error performance in wide networks shall be the EFS ratio for a 64-kbps channel. The terminal-equipment to terminal-equipment performance requirement for the EFS ratio is 0.99 for a circuit traversing each HRC, as shown in figure 5.16.

TABLE X.   Error-free-second ratio allocation.

SEGMENT	PER SEGMENT	HRC		
		GLOBAL	OVERSEAS	INTRA-CONTINENTAL
Tail	0.9996	---	---	---
320-km terrestrial segment	0.9995	---	---	---
Satellite or transoceanic cable	0.9997	0.9936 ---	N/A ---	0.9968 ---
HRC	---	0.9916	0.9936	0.9949

a. Global Hypothetical Reference Circuit (HRC)

| Tail segment | Terrestrial segment (320-km) | Satellite or transoceanic sumarine cable segment | Satellite or transoceanic sumarine cable segment | Terrestrial segment (320-km) | Tail segment |

b. Overseas Terrestrial HRC

Twelve 320-km terrestrial segments

| Tail segment | | | | | | | Tail segment |

c. Intracontinental HRC

| Tail segment | Terrestrial segment (320-km) | Satellite segment | Terrestrial segment (320-km) | Tail segment |

LEGEND:

● user terminal interface

○ intersegment tandem connection
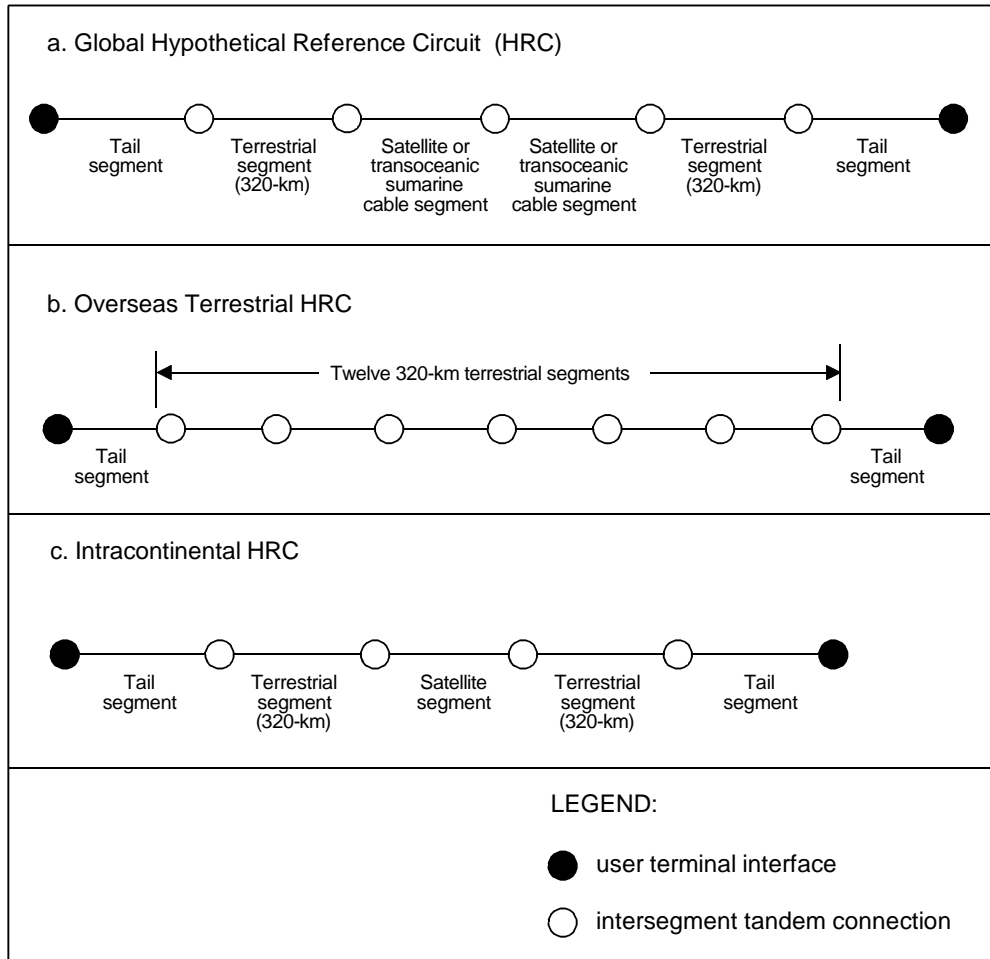
FIGURE 5.16. HRCs for wide networks.

5.8.4 <u>Tactical networks</u>. Three HRCs exist for U.S. tactical circuits:

a.   The first HRC, shown in figure 5.17, consists of six internodal line-of-sight (LOS) radio links in tandem. Each internodal LOS radio has a nominal distance of 50 km with an 8-km down-the-hill (DTH) millimeter wave or cable link on each end.

b.   The second HRC, shown in figure 5.18, consists of one internodal troposcatter link covering a transmission distance of 200 km in tandem with two internodal LOS radio links of 50 km each. Each troposcatter and LOS radio link has an 8-km DTH millimeter wave radio or cable link on each end.

c.   The third HRC, shown in figure 5.19, consists of two tactical subnetworks interconnected by wide network elements, as provided by the DCS or public switched telephone networks (PSTN). In this case the information transmits up to 12 LOS radio links and 24 DTH links.

The contribution to the overall circuit error ratio allocated to tactical network elements is provided in table XI.

TABLE XI.   <u>Operational bit error ratios for HRCs that use tactical network elements</u>.

| TYPE OF SECTION | CONTRIBUTION PER CIRCUIT | |
	BIT ERROR RATIO (BER)	% OF ANY MINUTE
LOS radio	1×10^{-4}	99.0
Tropo radio	4×10^{-4}	99.0
DTH radio	1×10^{-5}	99.0
DTH coaxial cable	1×10^{-6}	99.9
DTH fiber optic cable	1×10^{-8}	99.9

NOTE: The operational error rates are transmission errors and do not include effects of error correction or encryption devices.

5.8.5 <u>Subscriber networks</u>. Subscriber terminal equipment is connected to the local base-level or tactical network via

subscriber network elements. Four HRCs applicable to subscriber networks exist. The first two are applicable to both strategic and tactical subscribers. The third and fourth are applicable to tactical subscribers only.
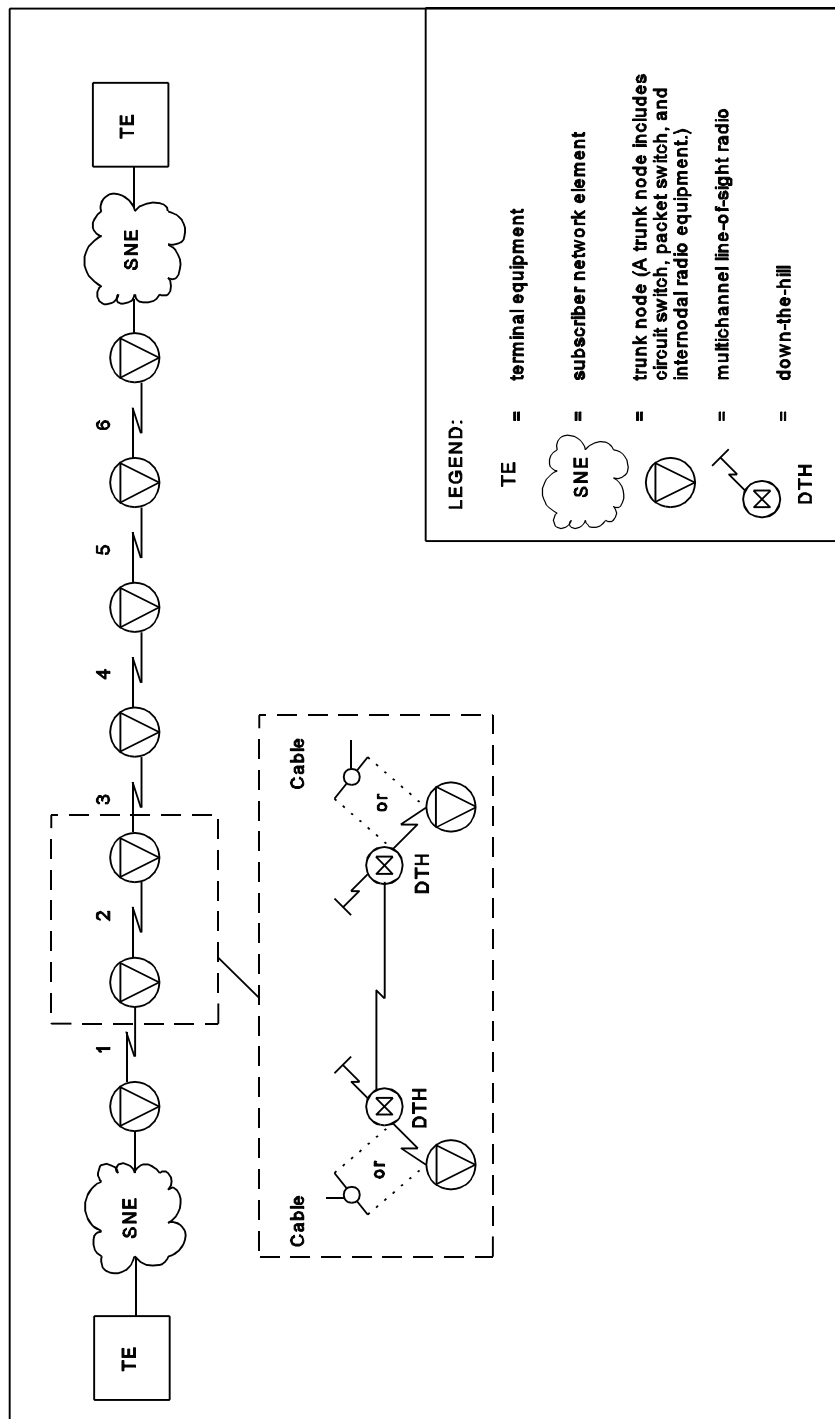
FIGURE 5.17. HRC for tactical networks based on LOS and tropo radio links.
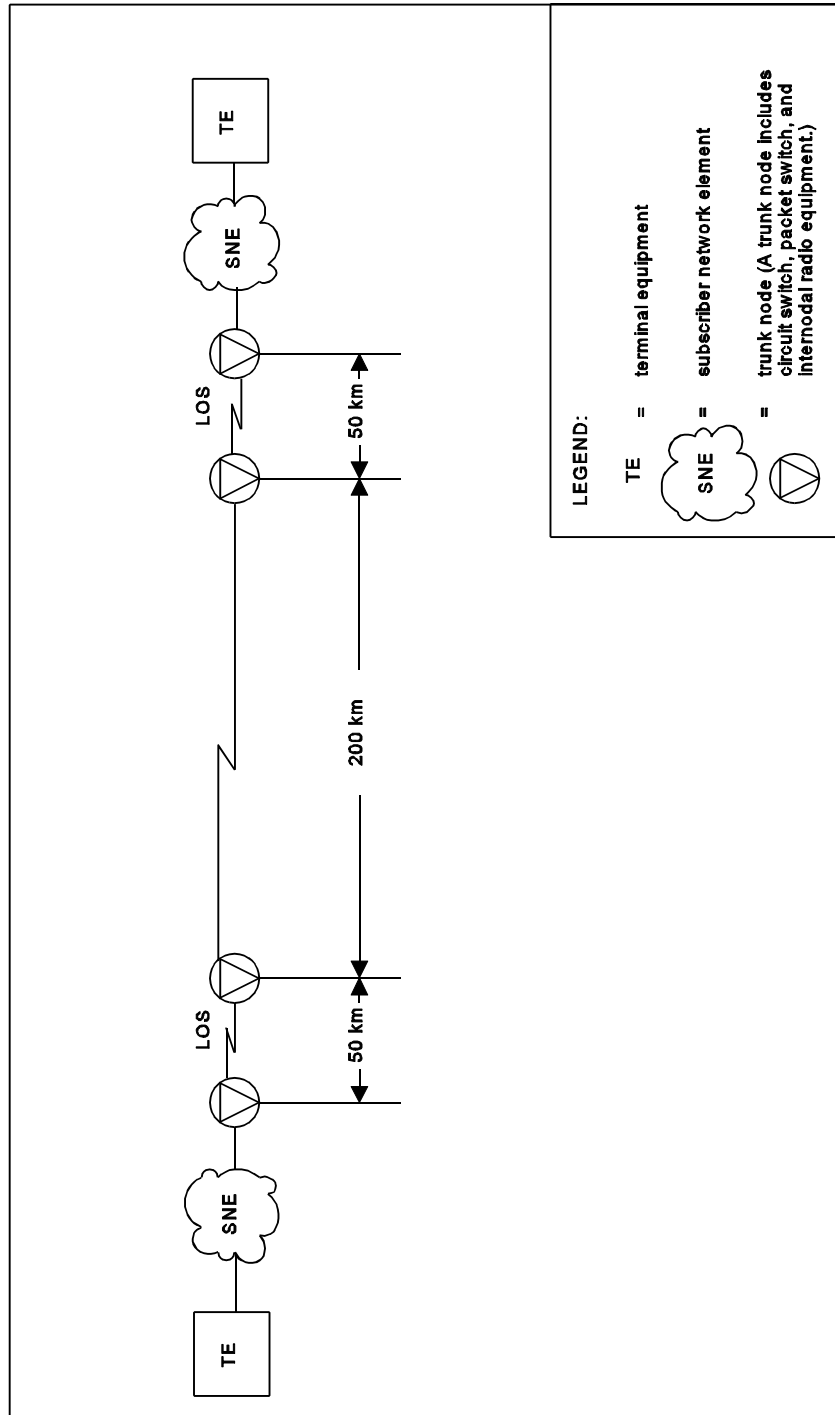
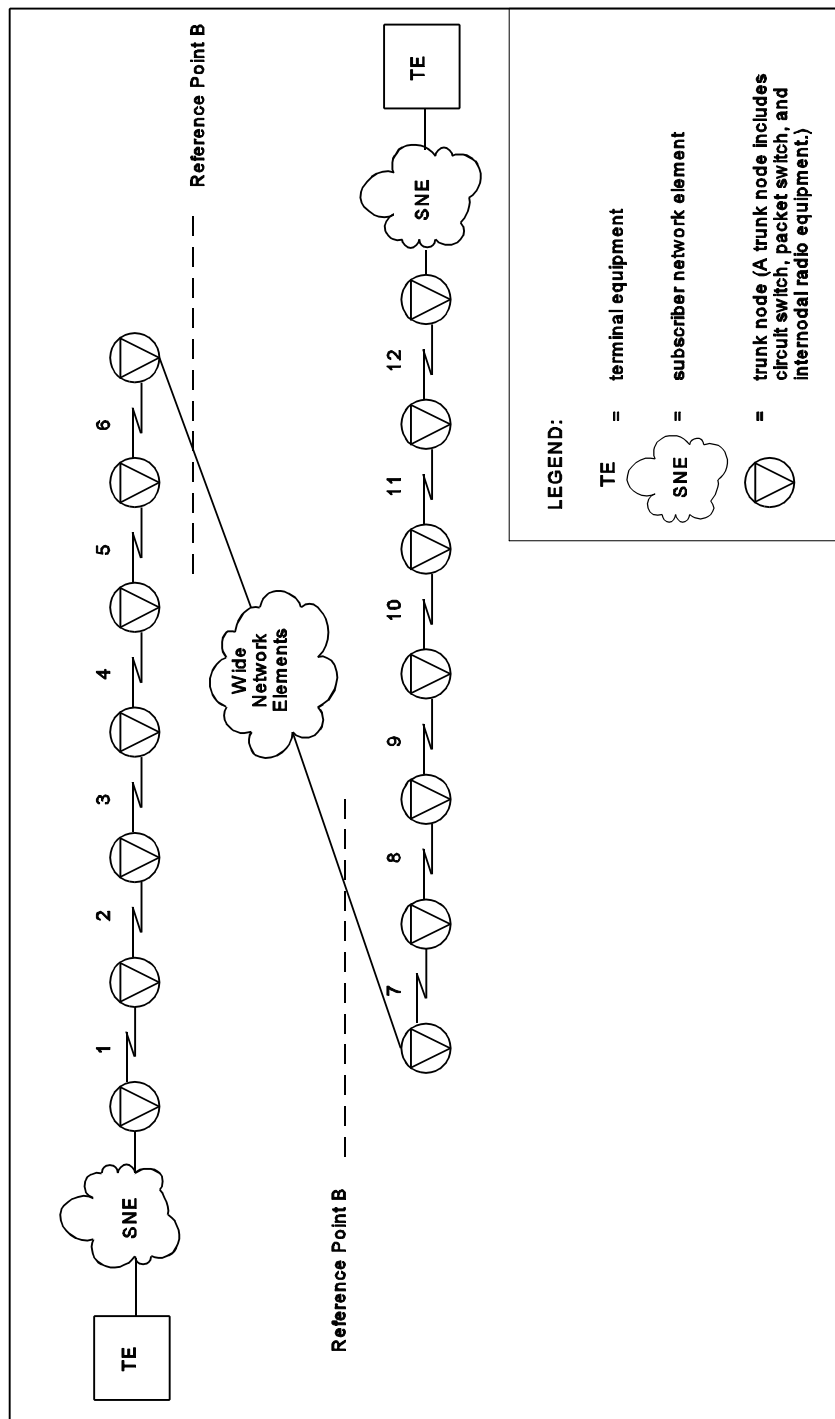FIGURE 5.18. HRC for tactical networks based on LOS radio links.

LEGEND:

TE = terminal equipment

SNE = subscriber network element

= trunk node (A trunk node includes circuit switch, packet switch, and internodal radio equipment.)

FIGURE 5.19. HRC for tactical networks interconnected by wide-network elements.

a. A direct metallic cable connection between the subscriber's terminal equipment and the local circuit or packet switch. The cable may be up to 4 km long.

b. A LAN complying with LAN standards ISO 8802.3, 8802.4, or 8802.5.

c. A radio network made of combat net radios.

d. A mobile subscriber radio terminal.

The contributions to the overall circuit bit error ratio (BER) allocated to subscriber network elements is provided in table XII.

TABLE XII.   Operational error rates for HRCs that use subscriber network elements.

	CONTRIBUTION PER CIRCUIT	
TYPE OF SECTION	BIT ERROR RATIO (BER)	% OF ANY MINUTE
Metallic cable connection	1×10^{-6}	99.9
Local area network	TBD	TBD
Radio network	4×10^{-3}	95.0
Mobile subscriber radio terminal	TBD	TBD
DTH fiber optic cable	1×10^{-8}	99.9

5.9 Numbering plans. A standard numbering plan format shall be employed on all trunks that cross-reference point B. This includes all joint and international circuit- and packet-switched trunks.

5.9.1 Circuit-switched trunks. Telephone numbers, as they appear on joint circuit-switched trunk interfaces, shall consist of a three-digit area code and a seven-digit subscriber number unique to each area code. Telephone numbers for international calls shall consist of an international access prefix (IAP), in addition to the area code and the subscriber number.

5.9.1.1 International access prefix. The IAP for calls between U.S.-tactical subscribers and NATO-tactical subscribers,

reference point B (NATO), shall comply with STANAG 4214 and its
description of the nationality identifier (NI). The NI is of the
form 9CC, where CC is a two-digit country code. The IAP for
calls between U. S.-strategic subscribers and strategic
subscribers of other nations shall comply with CCITT
Recommendations E.163 and E.164.

5.9.1.2 <u>Area codes</u>. The area codes for calls between
U.S.-tactical subscribers and NATO-tactical subscribers shall
comply with STANAG 4214 and shall be of the form NCC, where N=0,
1, ..., 8 and CC is the two-digit country code. Area codes for
calls between U.S.-joint tactical networks shall comply with the
Joint Pub 6-05 chapter titled *New Integrated Tactical Numbering
Plan*. Area codes for base-level and wide-network elements shall
comply with DCAC 370-175-13, the section titled *DSN Worldwide
Numbering and Dialing Plan*.

5.9.1.3 <u>Subscriber telephone numbers</u>. The standard telephone
number, as it appears at joint and combined trunk interfaces,
shall have seven digits. The seven digits may consist of two
subcomponents: a unique switch code for each area code, and a
unique subscriber number for each switch code. Systems, which
employ deducible directories, automatic subscriber affiliation,
and flood-search routing shall use all seven digits as the unique
subscriber number.

5.9.2 <u>Packet-switched trunks</u>. The address of the called
terminal shall be provided in the call request packet in
accordance with CCITT Recommendation X.31. As an objective, DoD
will evolve toward an integrated addressing plan applicable to
both circuit-switched and packet-switched trunking. In the
interim, packet-switched network elements shall comply with
standards adopted for use by DDN.

5.9.3 <u>Digit capacity for international systems</u>. The number
length for international calls may be increased to accommodate
future network requirements (see CCITT Recommendations E.163, the
section titled *Digit capacity of international registers*, and
E.164, the section titled *Number length*). The digit capacity of
registers required to process international calls should provide
a minimum capacity of 15 digits. This digit capacity does not
include all digits dialed by telephone subscribers, such as
access and priority digits.

5.9.4 <u>Subaddressing (network address extension)</u>. The seven-
digit subscriber number shall identify connections at reference

point A. Additional subaddressing required to identify subscriber-to-network terminations or service access points shall be transparent to the local- and wide-network elements. For base-level subscribers, up to 40 digits may follow the subscriber number, as illustrated in CCITT Recommendation E.164, the section titled *Address information*. Subaddressing for tactical subscribers is a subject for further study.